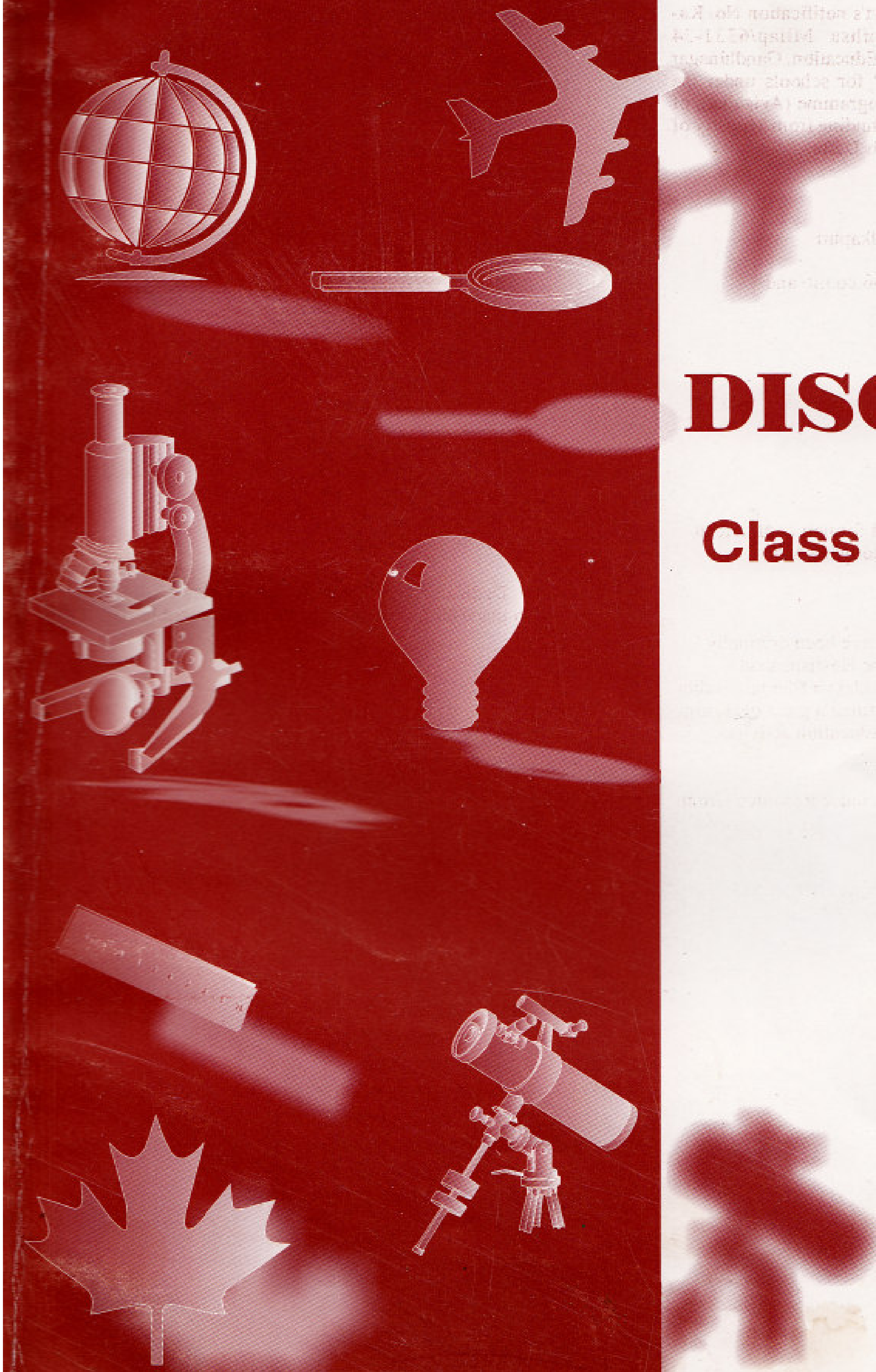

# DISCOVERY

## Class 7

SAHAJ-Shishu Milap, Vadodara

**Discovery Class 7**
Originally approved by the Gujarat Govt's notification No. Ka-chha-uu-Grant-Vigyan Shikshan-Shihsu Milap/6331-34 13.4.2000 of the Directorate of Primary Education, Gandhinagar for use as the textbook in Classes 5-7 for schools under the Learner Centered Science Education Programme (Avishika), of SAHAJ-Shishu Milap, Vadodara under funding from Ministry of Human Resources and Development, New Delhi.

Published by
SAHAJ-Shishu Milap
1 Shrihari Apts, Behind Express Hotel, Alkapuri
Vadodara, Gujarat-390 007
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Price Rs 60/-
Second English Edition, June 2006

Dedicated to all students and teachers
who made earlier versions of this book possible



The content and pedagogy of this book have been originally inspired and adapted from the work of the Hoshangabad Science Teaching Programme (HSTP), Eklavya Bhopal. Earlier Gujarati versions of this book have benefitted a great deal from feedback of several teachers, scientists, education activists, children and friends.

Translation for this edition: Discovery Science Resource Group

Design: S.M. Graphics, Vadodara

Printed at: Preet Infotech, Vadodara. Phone : 0265-2510364

The most beautiful thing we can experience is the mysterious. It is the source of all true art and all science. He to whom this emotion is a stranger, who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed.

*-Albert Einstein*

# DISCOVERY

For the scientist in the child

## Class 7

**SAHAJ-Shishu Milap**
Vadodara

# Discovery

Dear Children,

This book is meant for doing science. Not memorising. Every chapter has experiments many of them can be done with material easily available. Please DO all the experiments given. Try and answer the many questions posed. Discuss with your friends, with your teacher, and with others interested other ideas and doubts that crop up. Science is much more fun when you do things and especially when you do experiments. Allow yourself to experience the joy of discovering things, the fun in finding small and big things by yourself.

There are no facts for memorising in this book and there are no prizes for how well you can recollect them. In fact we have given very little 'facts.' Science is about knowing and appreciating the principle behind how a satellite moves or how a motor works. Science is about understanding and learning things around us: the soil, the rocks, the air, the water, the animals, the birds and the insects, the sun, the moon and the stars. Why does a particular insect attack a crop and why are there others that protect it? Why are eating certain types of foods more important? Why does it rain in some places a lot and why are there deserts in others? Does planting trees help in increasing rains? What causes a rainbow and can I create one in the classroom? And so on - there are so many exciting things one needs to know, to do and to find out.

Many things in this book are dependent on you bringing things from home before the class. Do bring them and remind your teacher in case even if she forgets. Some of the things are given in the science kit supplied for your class along with this book. Many things require going for small field trips outside the class. Do up and go when required. You will be doing experiments in groups of four. That way we learn how to share things and understand and do things together. A lot of things become clearer when you discuss things with your friends and people senior to you.

This book is designed in such a way that you will not need a separate notebook. This is a textbook and a workbook. Write your answers *in* the book. You will also save on paper! Use the margins and empty space to note things that have occurred to you, things that you have found and things you need to find answers to. Many great scientists do this. Remember there are no foolish or worthless questions.

# Discovery

Please write to us about how you find this book? Do you enjoy doing science? Do you go on field trips? Are you able to do all the experiments? Are there any problems and difficulties?

Waiting to hear from you,
**Problem Cruncher**
c/o, Shishu Milap Discovery Team, 1 Shrihari Apts
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Email: shishumilap@wilnetonline.net, sahajbrc@icenet.co.in

**Acknowledgments**
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# 1 Flower and Fruits

**Things you Need**

**For Every Group:** Different type of flower and fruits, blade.

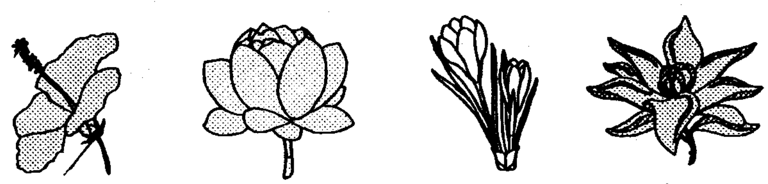
**Note for the Teacher**

A day before starting the lesson, ask students to get fruits and flowers. Take care while cutting flower and fruits with blade.

**New Words**

Thalamus
Stalk, pedicel (or pedicle)
Follicle
Corolla
Androecium
Anther
Pollen grain
Gynoecium
Stigma
Style
Ovary
Ovule
Female flower
Male flower
Incomplete flower
Complete flower
Simple flower
Compound flower
Fruit
Horizontal section
Vertical section

The word "flower" reminds us of beauty, color and fragrance. We look at our favourite fruits, and our mouth starts watering. Our body has parts like hand, foot, chest and head. Did you know that flowers also have various parts? Fruit-giivng trees like those of apple, mango, pomegranate produce flowers first and after a few days they develop small fruits. How does this happen? We will learn about flowers and fruits in this chapter.



**Flower**

To study about fruits and flowers, we will take a small tour. While going around do not forget to carry a polythene bag, scissors and a knife. As far as possible collect big sized flowers and fruits: they will be easier to study.

**Take Care**

Pick only a few flowers and fruits: you would not need many. Take care not to damage the vegetation growing nearby. Make a list of all the flowers and fruits you collect while going around.

______________________________________________

______________________________________________

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______________________________________________

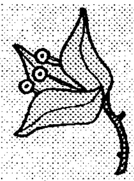
Do you know any plants that have no flowers and fruits? Discuss with your teacher and make a list of such plants.

______________________________________________

______________________________________________

**Two types of plants are observed in nature: Flowering Plants and Non-Flowering Plants.**

# Flowers and Fruits



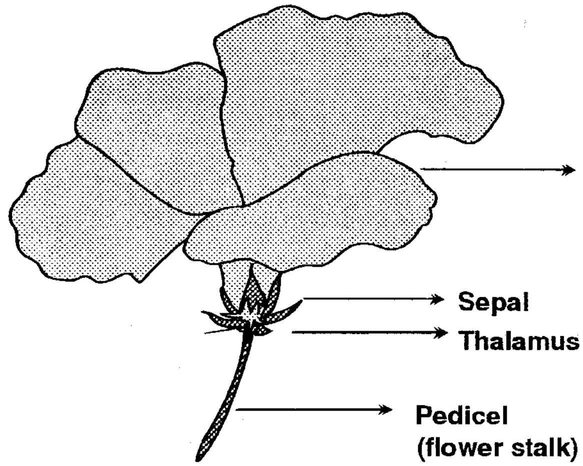
Bougainville have coloured calyx.

**Did you know?**

On November 5, 1766, Louis Antoine de Bougainville sailed from Nantes aboard the frigate *Boudeuse*. The French government commissioned Bougainville expedition leader; the objective, circumnavigate the world. The expedition explored the Pacific and returned to France in March 1769. The vine they found in Brazil was named for the expedition leader.

In addition to the vine, straits, bays, a reef, and a mountain were named after him. He was a mathematician and wrote a treatise on integral calculus, a soldier who defended Quebec in the Seven Years War, an explorer, captain of the *Guerrier* which fought English ships during the American Revolution, a vice-admiral, a field marshall, secretary to King Louis XV, and, escaping beheading during the French Revolution, a count and senator to Napoleon.

Let us study the flowers and fruits we have collected.




According to the picture drawn, identify pedicles, stalks of flowers and thalamus from the flowers collected.

**All parts of the flower are attached to the thalamus.**
Based on the picture identify calyx. Is it open or united ?
Does the calyx of all flowers have green colour or are they of different colours ?

---

If there were no calyx (plural calices), what would happen ? Look at the bud of the flower, and try and find the answer.

---

Based on the picture above, identify the petals from the collected flowers. These are also known as corolla. Are they free or are they united ?

---

Do the corollas of all flowers have same colour or are they of different colours?

---

Is the colour of the flower, the same as the colour of corolla, i.e., the colour of petals ?

---

Is the number of petals of all the flowers the same or different ?

---

Do the flowers that you have collected have any smell ?

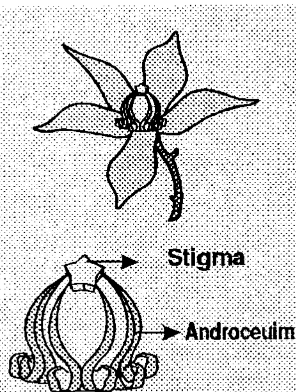
---

Complete Table 1 from the information you have gathered.

---

Table 1

| No. | Name of flower | Colour | Smell | Calyx: free or united? | Corolla: free or united? | Bees or insects seen? |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |




**Gynostegium**

In the caltropis flower, gynoecium and androecium are fused this condition is known as *gynostegium*.

**Did you know?**

*Caltropis gigantea*, or Caltrope, King's Crown, Goat Bush, Indian Milkwood is native to tropical Asia. All parts of the plant are poisonous to humans. The milky sap can cause blindness if it comes in contact with the eye. It is a larval food plant for the Monarch Butterfly. It is used in Ayurveda and Unani as medicine.

Think why do different flowers have different colours and smells?

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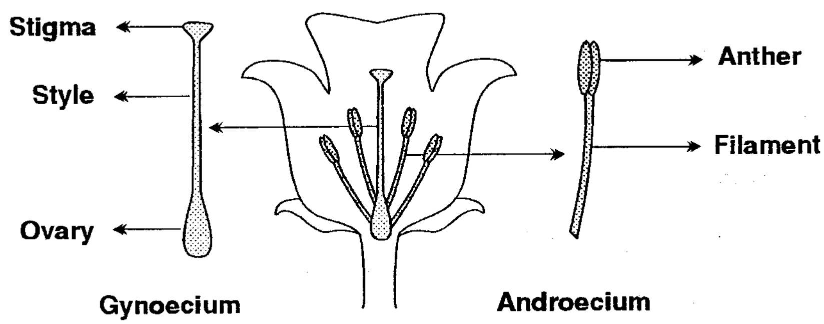
Till now you were studying outer visible part of the flower. Now let us identify the inner part of the flowers. For this take flowers of Dhatura, Caltropis and Hibiscus. To visualize inner parts of the flower, remove the petals. Find out the parts as shown in figure.




Do all the flowers with you have androecium and gynoecium ?

______________________________

**The flowers having both androecium and gynoecium is called a complete flower. The flowers having only gynoecium is called a female flower.**

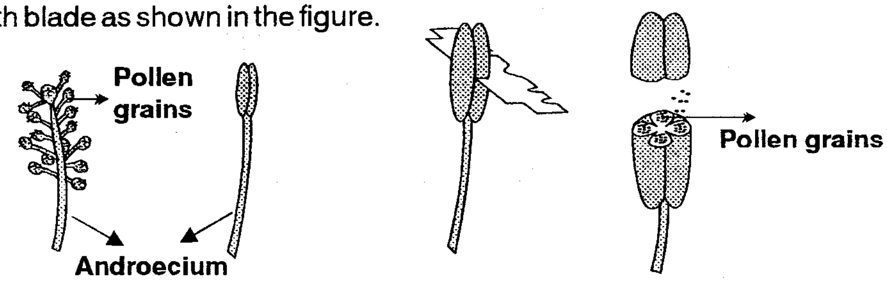
What is the flower with only male flower known as ?

______________________________

Now, we will study the details of the inner parts of a flower. For this, use a magnifying lens where required. Find out the androecium in the flower collected by you - see figure above.

Swollen upper part of the long stick is known as **anther.** In many flowers on the anther you can see fine white or coloured grains. They are known as **pollen grains.**

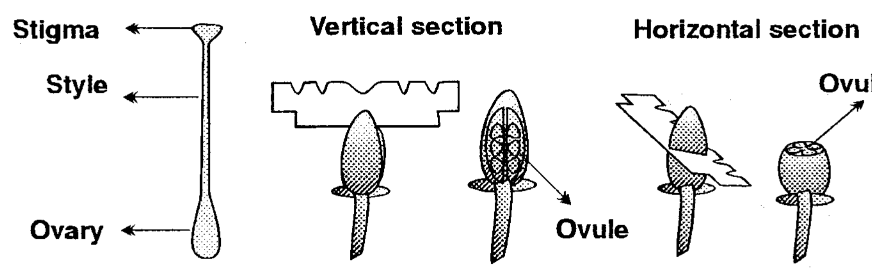
On those anthers where you cannot see such pollen grains, cut the anther with blade as shown in the figure.




Now observe it with magnifying glass can you see pollen grains ?
Where you can find anther in the hibiscus flower ?

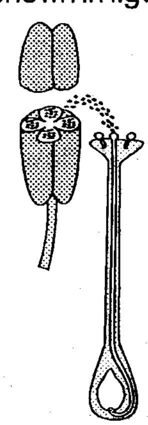
---

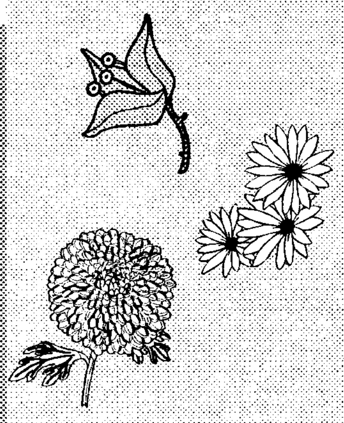
Take the flowers of Hibiscus and Dhatura; to observe gynoecium remove the petals, now you are left with gynoecium. On the basis of diagram find out the ovary in both the flowers. Give a vertical cut to one of the ovary and give horizontal cut to the other as shown in figure.




Observe the inner part of the ovary with the help of a magnifying glass. Draw the figure as per your observation. **Inside the ovary there are ovules.**

Try to understand the process of formation of seed, starting from traveling of pollen grain from the anther as shown in figure.





Observe the bougainvillea, sunflower and marigold flowers. All these flowers are not single but a group of many flowers. So they are called compound flowers.

**Did you know?**

The tallest flowering plant is the eucalyptus which can reach 132 m in height.

The smallest flowering plant is the duckweed which floats on the surface of pond water. It is 0.5 mm long

The largest flower is the stinking corpse lily which can be up to 90 centimetres in diameter.

The smallest flowers are found on the artillery plant. They are only 0.35 millimetres in diameter.

You can see that in many flowers the length of gynoecium is smaller than androecium, so pollen grains can fall on stigma easily: e.g., brinjal flowers. But in many flowers gynoecium is longer than androecium, e.g., hibiscus flowers. Now you have already learnt that for the formation of seeds, pollen from anthers must fall on the stigma of gynoecium. How can this happen in those flowers where the gynoecium in longer as in a female flower? Look at the figure shown below and find the answer.

______________________________________________

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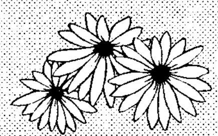
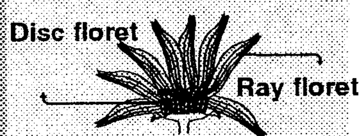
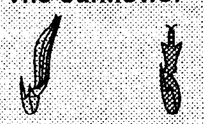


Sunflower



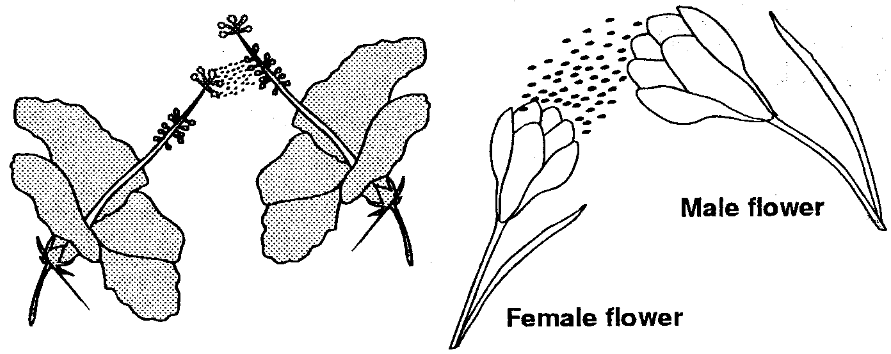

Horizontal section of The sunflower




The sunflower is a compound flower: we can see two type of arrangements of the florets in the sunflower.

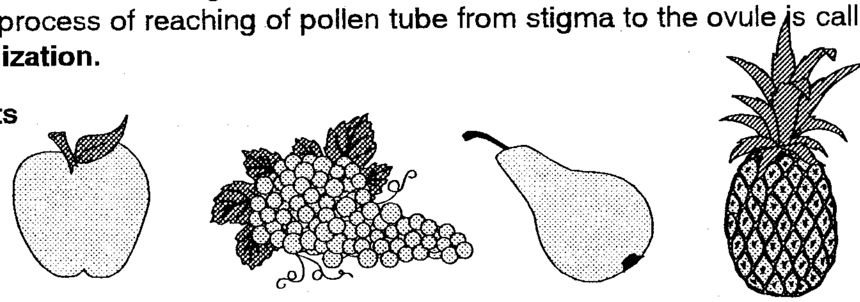
1. **Disc Floret** - Each independent disc floret is one complete flower containing gynoecium and androecium.

2. **Ray Floret** - Each independent ray flower, either it is a female flower or has a sterile flower present. A flower that does not have gynoecium or androecium is called a **sterile flower.** Such flowers are one type of incomplete flowers.




The process of travelling of pollen grains from anthers to the gynoecium is called **pollination**. When the pollen grains of one flower fall on the stigma of the same flower, this is called self-pollination. When the pollen grains of one flower falls on the stigma of another flower this is called cross-pollination. The process of reaching of pollen tube from stigma to the ovule is called **fertilization.**

**Fruits**



Now we will learn about fruits. Bring any seasonal fruits available. Let us understand how fruits are formed. We have learnt earlier that fertilization takes place only after the development of the ovule.

How are fruits useful for the seeds inside ?

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List out those fruits which have small seeds and are juicy and fleshy: for example, the apple.

______________________________________________

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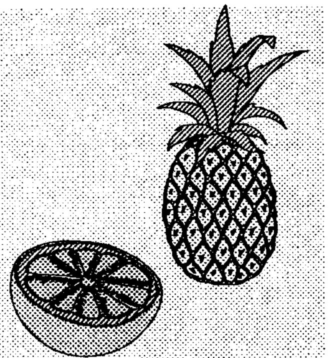
# Flowers and Fruits



Lemon, orange and lime are juicy fruits that have a lot of vitamin C.

**Did you know?**

Flowers are sometimes useful to us for other reasons than just for decoration. A few flowers are important foods; broccoli, cauliflower and artichoke are collections of flower buds which we eat as vegetables. Many flowers are used to add taste to food. Cloves are dried flower buds and saffron comes from the female parts of the purple autumn crocus. In some countries the petals of roses and marigolds are used to flavour food such as soups and salads. Dandelion and elderberry flowers are used to make wine. In China, fried squash flowers are considered to be a luxury food! Honey is made from nectar. The best nectar for making honey comes from clover, orange and sageflowers.

Some flower petals are used to make expensive perfumes, such as jasmine, mimosa and rose. The petals of some brightly coloured flowers are used to make coloured dyes for clothes.

Such fruits are called juicy and fleshy fruits. Make a list of such fruits from the fruits collected by you: those having **big** seeds and those having less flesh between seeds and the fruit skin (for example, berries).

________________________________________

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Such fruits are known as **dry fruits.** Make a group of those fruits, which split open after ripening. For instance, caltropis.

________________________________________

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Make a list of those fruits in which seeds are shed after ripening and decay. For example, guava

________________________________________

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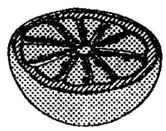
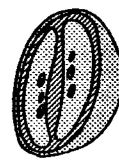


**Horizontal section**



**Vertical section**

Now take the vertical and horizontal cut of the ovary and fruits of the same plant; and study the arrangement of ovules in ovary and seeds in fruits. Write your observation.

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**Plants can change sex too!**

Cucumbers are famous for changing from male to bisexual to female and then to parthenocarpic as they grow. What is parthenocarpic? It means literally virgin fruit. The last flowers on some cucumbers do not need to be pollinated to produce a fruit...they make the fruit on their own!

Another interesting example is the Abelmoschus (hibiscus) in the greenhouse. The flowers last only one day and are bisexual. The flower hedges its bets. In the early morning the female parts stick out beyond the stamens to be pollinated with pollen from some other plant. If this happens, fine, but if it doesn't happen by afternoon, the styles curl backwards and push the stigmas against the stamens in the flower; it is a self-pollination. By evening the flower senecas (becomes old) and fruits begin to develop.

# 2 Life Cycle of Animals

**Things you Need**

**For Each Class**

Bottom of the broken pitcher, eggs of frog, water.

**For Each Group**

Two tin boxes, rubber band, paper, pins, glass cups dropper.

**Note for the Teacher**

Student should observe every day.

While observing frog's egg and tadpole take care that they are not dropped.

After the development of tadpole, add algae brought from the pond in the container.

Keep on changing water in the container.

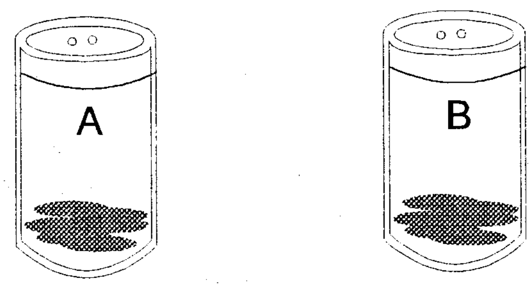
**New Words**

Life cycle
Larva (*plural*: larvae)
Pupa (*plural*: pupae)
Adult
Tadpole
Metamorphosis

After the first flush of monsoon, when small pits and holes are filled with water, we observe that small organisms and vegetables start to grow. Also we see different algae, small frogs and some times small fishes and many type of different microorganisms. You shall be surprised to see that many red, velvet and soft snails appear, as soon as the monsoon sets. Where do these wonderful things come from?

Then after a few days they disappear. Some people believe that these organisms arise from the water in the pits or in the soil or from the compost. Is this true? In this lesson, we will perform some experiments, which will help us explore these questions. Also we will study various stages of development, from egg to adult - the Life Cycle of some animals.

**Experiment 1: Life Cycle of a House Fly**

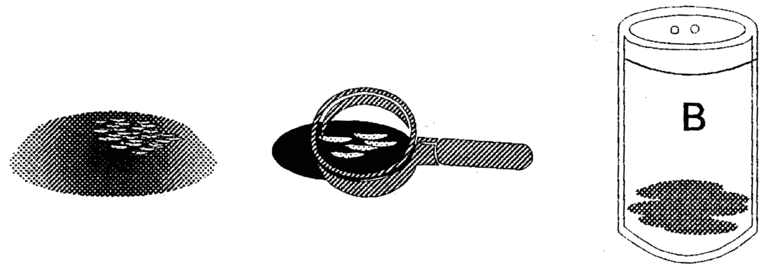



For this experiment take two metal boxes. If metal boxes are not available, then you can take glass cups, coconut shells or pots. Label one container **A** and the other one as **B**. Place some fresh cow dung, on which there are no house flies, in box **A**. Tie the open end of the box tightly with paper with the help of a thread or a rubber band. Now with the help of a needle or a pin, make small holes so that air can circulate in the box; the holes should not let house fly or any other insect get inside. Leave the rest of the cow dung on the ground, uncovered so that house flies can sit on it, and observe regularly.

As soon as you see a house fly sitting on the exposed cow dung, observe its behavior minutely. Observe specially any fly that tries to enter the cow dung throw its many pores.

When you see that a fly sitting for a long time, observe the back side of that fly. Can you observe a white long thing coming out from the back side of the fly?

If no, then wait for some time. As soon as the fly sits again, observe its back side. The white long thing coming out is the egg of the house fly. Use a magnifying lens to observe if required. After the house fly starts laying eggs, place the exposed egg-laden cow dung in box **B**. The picture below shows a section of egg-laden cow dung.




Observe the eggs carefully and draw a picture of it below.

Close Box **B** also with paper and rubber band or thread. Here also make small holes with help of pin or needle - holes big enough so that air can circulate but such that no house fly or any other insect can enter the box.

This is the first day of your experiment and we will call it Day 1; subsequent days of your observation will be labeled Day 2, 3, 4, etc. From Day 1, you will need to open and observe boxes A and B everyday. This experiment will last up to ten days.

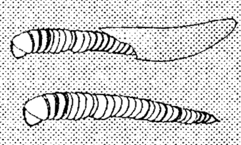
**Precautions**

1. Whenever you open the boxes for observation do not allow any house fly to enter the boxes.
2. After observation do not forget to immediately close the boxes with paper.

Complete the table below every day with your observations.

**Life Cycle of House fly**

**Eggs**



**Caterpillar**

**Pupa**

**House Fly**

**Larva: Word History**
*n. pl.* **Larvae**

The word *larva*, referring to the newly hatched form of insects before they undergo metamorphosis, comes from the Latin word *larva,* meaning "evil spirit, demon, devil." To understand why this should be so, first we need to know that the Latin word also was used for a terrifying mask, and in Medieval Latin it could mean "mask or visor." *Larva* is therefore an appropriate term for that stage of an insect's life during which its final form is still hidden or masked, and New Latin *larva* was thus applied in 1691 by Carolus Linnaeus, the Swedish botanist who originated our system of classifying plants and animals. The word *larva* is first recorded in English in its scientific sense in 1768, although it had been used in its "spirit" sense in 1651 in a way that foreshadowed the usage by Linnaeus.

Source: http://dictionary.reference.com

**Table 1**

| Day | Name of Stage | Observed on which day | Behavior (What is it doing) | Colour | Diagram |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
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| | | | | | |
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On the second day of the experiment, look at both boxes and try to find out whether on the surface of the cow dung, **larvae** are coming out of the eggs. (See word history of larvae in the left column.) In the beginning these larvae are slightly bigger than the eggs. If you are unable to find out or locate eggs or larvae on the surface of the cow dung, then do some gentle digging and observe again.

In which box were you able to locate eggs and larvae?

___

Many a time, on the surface of the cow dung, very fine white particles are observed. These particles are not eggs but it is fungus (*plural*: fungi). In monsoon, such fungus grows all over. **Please do not mistake fungi for eggs.**

Try to differentiate between eggs and fungi by observing these with magnifying lens. On the second or the third day of the experiment in box B, you should be able to get larvae. Note this observation in the table. Does the larva move? Draw the picture of larvae after observing with a magnifying lens.

What do larvae eat to survive ?

Observe the changes occurring in larvae everyday. Observe minutely which day the larvae turn lethargic (or lazy).

From day the larvae become lethargic, start observing minutely. Do you observe that the larvae are getting covered by some sort of layer? Have the movements of the larvae completely stopped ?

When larvae reaches this stage it is known as pupa. An insect in the inactive stage of development, when it is not feeding, intermediate between larva and adult, is called **pupa** (*plural*: pupae). By which day do you observe pupae? Complete your observations in the table, using magnifying lens if necessary, and draw the diagram of a pupa.

Now start observing pupae everyday.

**Lest your house fly, fly away**

As you open the box for observations, please take care your house fly does not run away. Note in the table the days you get to see a fly.

After a fly is formed, what remains of the pupa? Only a shell or is there something else also?

Did you observe any flies coming out of box **A** ? What could be the reason for this?

### Larva and the Adult

The larva can look completely different from the adult form, for example, a caterpillar differs from a butterfly. Larvae often have special (*larval*) organs which do not occur in the adult form. The larvae of some species can become pubescent (that is arrive at the age at which sex glands starts functioning) and not further develop into the adult form (for example, in some newts). This is called neoteny.

It is a misunderstanding that the larval form always reflects the group's evolutionary history. It could be the case, but often the larval stage has evolved differently, as in insects. In these cases, the larval form might differ more from the group's common origin than the adult form.

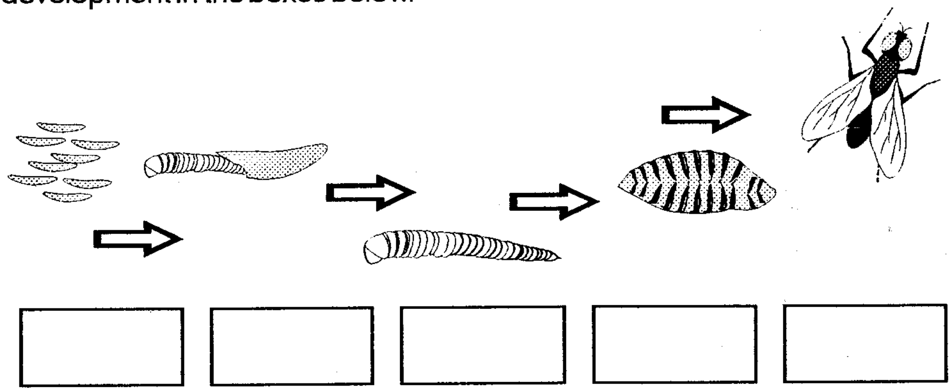
### Names of Various Kinds of Larvae

| Animal | Larvae |
|---|---|
| Hydrozoan | Planula |
| Fresh water mussel | Glochidium |
| Many Crustaceans | Nauplius |
| Butterfly, Moth | Caterpillar |
| Mosquito | Wriggler |
| Fly | Maggot |
| Eel | Leptocephalus |
| Bee | Schadon |
| Frog, Toad | Tadpole |

## Life Cycle of Animals

A house fly lays eggs, eggs develop into larvae, larvae into **pupae, and** pupae into house flies. The entire process is known as the **life cycle of the** house fly. Eggs, larvae and pupae and adult house fly: these **are different** stages in the life cycle of a house fly. Again the adult house fly will lay **eggs** and thus life goes on.

A diagram of the life cycle of a house fly is shown below. In this diagram, the stages of development are not labeled. Label the different stages of development in the boxes below.



For plants and animals, life cycles are generally drawn using such diagrams. After your observations in the above experiment, answer the following question.

In which box could you observe the various stages of the life cycle of the house fly: **A** or **B** or both ?

_______________________________________________

You had started your experiment with keeping cow dung in both boxes on the same day. But you could observe the different stages in one box only. Why do you think this happened?

_______________________________________________

_______________________________________________

Does the house fly develop from the cow dung (or compost) by itself ? Give a thought before you answer this question.

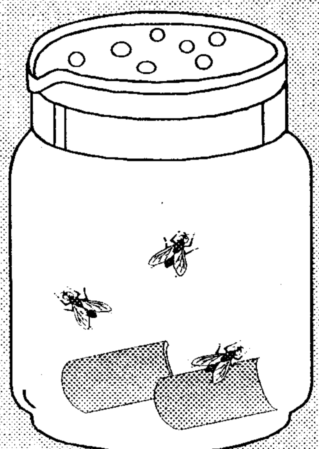
_______________________________________________

If a student, while performing this experiment, leaves the box open, then what problems could occur ?

_______________________________________________

_______________________________________________

### An Experiment

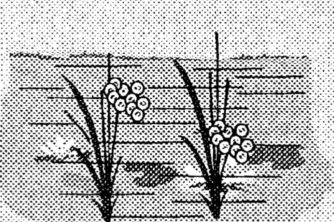


Put small pieces of banana or papaya in a glass bottle. Allow 2-3 house flies to enter the bottle and afterwards close the bottle properly with the lid. Allow circulation of air by making small holes in the lid.

Now observe all the stages, starting from the laying of the egg to the formation of the adult fly.

Many people think that flies are produced by the cow dung "on its own" **and** the larvae of the house fly are thus known as the compost/cow dung **larvae**. What would you say to such persons after the above experiment?

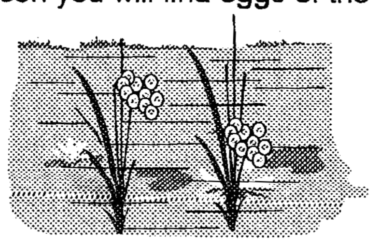
**Comparative Stages in Experiment**
In this experiment, why did we leave just plain cow dung in one of **the** boxes?

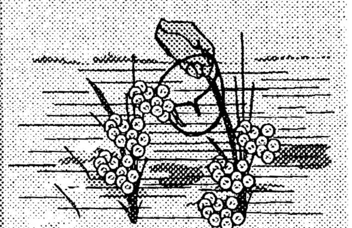


**Frog's Eggs**

Now you may have guessed that box A is placed just for comparison. If box **A** were not kept, than we might have concluded that house flies have been produced from cow dung. Having both boxes **A** and **B,** makes it is clear that house flies are produced from eggs.

**Experiment 2: Life Cycle of a Frog**
During the rainy season you will find eggs of the frogs in pits like the one shown below.





**Method for collecting frog's eggs**

Collect the water from the pond along with the eggs and some algae as well as soil and the other living organisms. The small tadpoles coming out from the eggs, feed on these.

After a couple of heavy showers, and when the pits are filled with water, you can find eggs of frogs fairly easily. Collect the eggs along with water in a wide-mouthed glass bottle. While collecting, take care not to scatter the group of eggs. Collect some algae also along with the water from the pit. After reaching your school, pour these eggs along with the water from the pit in a wide-mouthed container. This container should be approximately 15 cm deep (the bottom part of a broken pitcher will do). Also, pour the algae, that we have collected from the pit, into the vessel. Observe the eggs. Black and round bodies found in the center of the transparent and slimy fluid are *embryo* of the frog (embryo = an organism at any time before full development, birth, or hatching).

This experiment will last for a long period. If the water in the vessel is less, keep on adding garden water regularly. Do not add any other water. Consider Day 1 of the experiment as the day when you brought eggs to your class and Day 2, 3, etc., thereafter.

The egg and various stages developing out of the egg should **be observed** every day. Which day did you get to see the small baby frog ? **Does it appear** like a frog at all?

___

**Small frogs coming out of eggs are known as tadpoles (looks like a fish with a tail ).**

**How to make your observations after Day 1:**

Observe the changes taking place in the tadpole. Spend at least 10-15 minutes everyday for making notes, observations and drawing various stages.

Firstly, observe the tadpole in the water in the container. To observe its details, transfer it out into a transparent glass or plastic cup. Scoop out the tadpole gently with the help of a spoon or cup. Now you will be able to see clearly the tadpole - its top, bottom and even the sides. When the tadpole grows further you you will not be able to remove it with a cup, etc. In this situation you will have to observe it by placing it on your palm or on the lid of a wide-mouthed bottle.

Observe the tadpole everyday. As soon as you observe any change, or any new part, note your observation and draw this new change in your notebook. Also note when, on which day, you could identify the stages shown in the figures in the left column.

On which day were you able to observe the egg of the tadpole ?

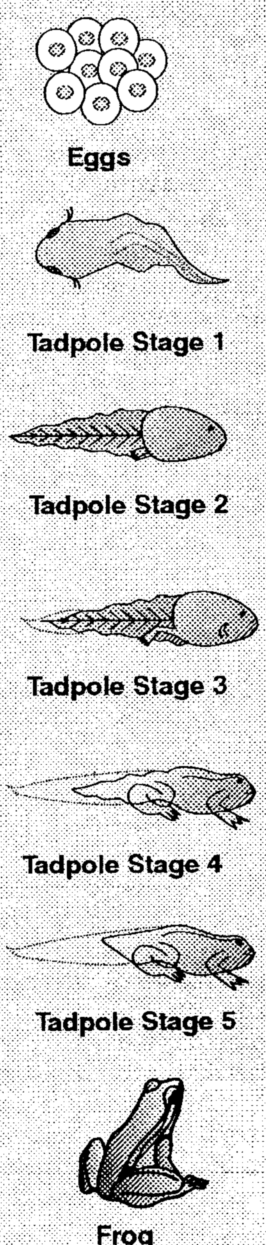
___

When the tadpole was 3-4 day old, could you see small frills below the eyes?

___

Try to observe the developing tadpole minutely and especially the organs developing on its lower parts. As you observe these organs, note your observations and draw the developing stages: Heart, intestines, vertebral column, urinary tracts, front foot, hind foot, etc.

**Life Cycle of a Frog**



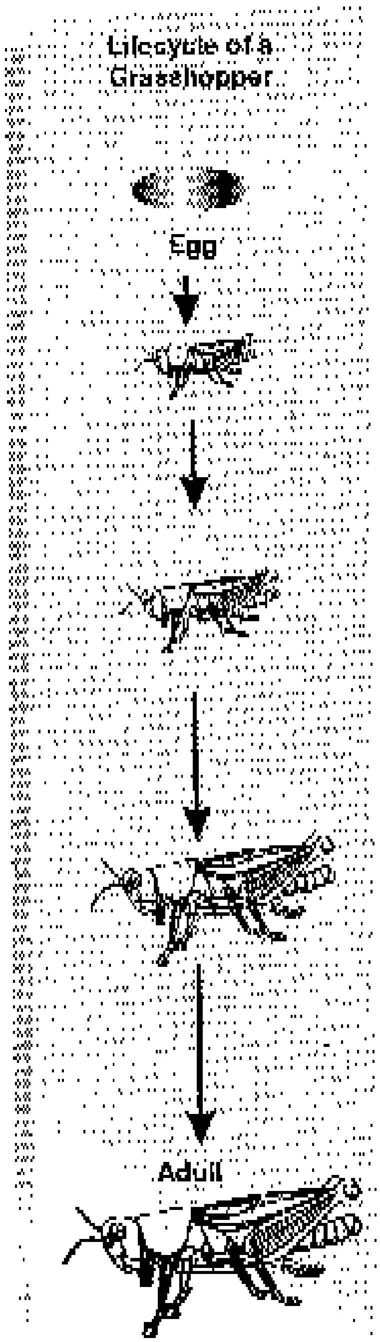
The day you observe the hind feet developing, place small stones in the center of the container in such a way that a part of the mound of the stones appears above the water surface. We do this as a developing tadpole needs to come out of water occasionally.

When do you observe that the frills have totally vanished ?

______ ______________ ______________

When did the tail completely disappear ?

______________ ______________ ______________




Fill in all observations on the changes occurring during the development of a tadpole into a small frog.

**Table 2**

| Sr. No. | Day (day 1, 2, etc.) Changes Observed In Tadpole | Drawing of the Observed Change |
|---|---|---|
| | | |
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| | | |
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Now answer the questions given below.

Why does the frog lay its eggs in water ?

How many days does it takes to develop frogs from the eggs ?

Name the stages of development observed in the life cycle of frogs.

Draw the picture of different stages of development of the frogs

Now if someone asks you whether the frog develops from rainy water or land, what would you tell her on the basis of this experiment ?

You observed from the experiments on house fly and frogs that the small baby produced from the eggs does not look like its parents. They become like their parents only after some changes. Generally during a life cycle, different animals show changes in form and habits at different stages of development. This process known as **metamorphosis** can be observed. Name two animals showing metamorphosis (that is a change in the form and often habits of the animal during normal development after the embryo stage).

**Another Type of Life Cycle**

Are life cycles of all animals like that of a house fly or a frog or are they different? Find out the answer to this question. See the picture shown in the screen on next page.

Here you can see different stages of development from egg to adult of a grass hopper. Do you observe any larvae in its development stages? Do you observe any pupae in these stages?

**Life Cycle of an Ant**

The life cycle of the ant consists of four stages: egg, larva, pupa, and adult. Fertilized eggs produce female ants (queens, workers, or soldiers); unfertilized eggs produce male ants.

**Egg:** Ant eggs are oval shaped and tiny (they are on the order of 1 mm long, but the queen's egg is many times larger).

**Larva:** The worm like larvae have no eyes and no legs; they eat food regurgitated by adult ants. The larvae molt (shed their skin) many times as they increase in size.

**Pupa:** After reaching a certain size, the larva spins a silk like cocoon around itself (against a solid object like the wall of the chamber) and pupates. During this [illegible] metamorphoses (changes) into its adult form.

**Adult:** The pupa emerges as an adult. The entire life cycle usually lasts from 6 to 10 weeks. Some queens can live over 15 years and some workers can live for up to 7 years.

## Life Cycle of Animals

Do you observe any change during development from larva to adult animal stage?

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______________________________________________

What is the difference between the life cycle of a grass hopper and a house fly and that of a frog?

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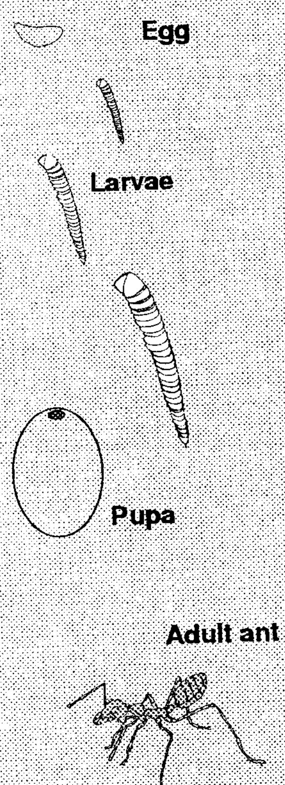
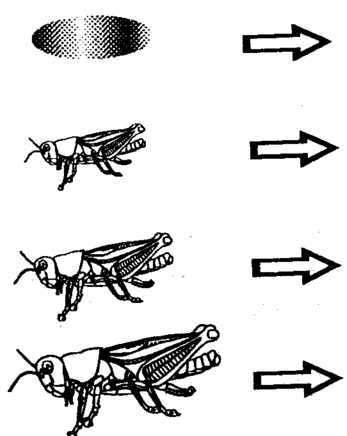
**Life Cycle of an Ant**




Life cycle of grass hoppers are quite similar to many organisms like bed bugs, crickets and red coloured insects found in the cotton plant. Bed bugs lay their eggs in cracks of chairs, walls and beds. If you find such eggs, then carefully place them in a small clean used injection bottle; cover the bottle with a stopper. Do not forget to make small holes in the cork with the help of a hot needle. Observe these eggs with help o f magnifying lens everyday.

**Draw different comparative stages of development that you observe in the insect (as compared to the grass hopper on the left).**



**Life Cycle of a Grass Hopper** **Life Cycle of an Insect**

Write down the names of five animals in which metamorphosis is not observed.

______________________________________________

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# 3 Time and Simple Pendulums

**Things you Need**

**For Each Class**

Puncture solution, meter scale.

**For Every Team**

Two empty injection bottles with stoppers, empty used refills, fine sand (that you obtain after sieving), string, small and big stones, a thick hard bound book.

**Note for the Teacher**

To make the sand clock, use as much as possible fine sand. To start the oscillations of the pendulum, students may not shake the pendulum.

**New Words**

Pendulum, Oscillation, Time Period

In the chapter on Seeing the Skies with the Naked Eye, you will make two types of clocks. Why do we use a clock?

______________________________

How can we estimate time without clocks?

______________________________

Are days/nights in summer longer than in winter? Or shorter?

______________________________

Are days/nights in winter longer than in summer? Or shorter?

______________________________

You would have noticed that days and nights are not equal generally. Do you know on which days they are actually equal?

______________________________

What we call a day includes night a day is divided into 24 equal parts. What do we call each part?

______________________________

How many minutes are there in each hour?

______________________________

How many seconds are there in each minute?

______________________________

The *second* is the smallest unit of time we normally use. In nature, there are several events which occur periodically and cyclically like the seasons, the flowering of mango trees, full moon nights, and so on. Write below other such examples and the time periods with which they occur.

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______________________________

# Simple Pendulums

In a clock, what are the actions (or events) you observe repeatedly?

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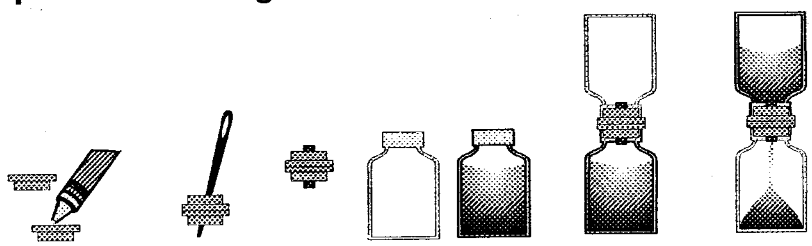
After how much time lapse, do these events occur?

______________________________

Let us make different types of clocks and see how we can measure time with them.

**Experiment 1: Making a Sand Clock**



Take two empty used injection bottles. As shown in the picture above, stick their stoppers with a sticky gum. After the gum solution on the stoppers dries, make a hole in both the stoppers so that a half centimeter empty refill can pass through them. In one of the bottles take sand that is fine enough to pass through the refill smoothly. Close the bottles with the stoppers as shown above. Note the time taken by the sand in the bottle above to pass through to the bottle below. Repeat the experiment 4-5 times and note the average of your readings. What is the time taken on the average?

______________________________

Write below the limitations of the sand clock.

______________________________

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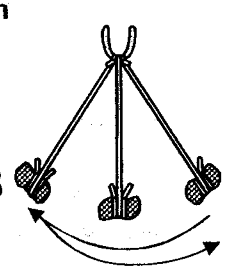
*You have learnt how to make a sand clock. But it cannot measure small units* of time like a second. For that, we look into Experiment 2.

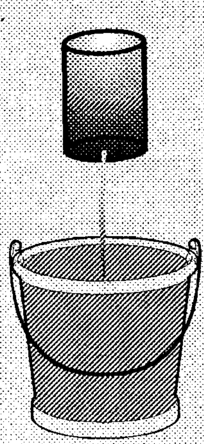
**Experiment 2: Make a Pendulum**




Take a medium-sized stone, tie a one-meter long string around it and hang it on a nail on the wall or any other such support so that it can swing freely.

**Pendulum Talk**

1) The pendulum was discovered by Ibn Yunus al-Masri during the 10th century, who was the first to study and document its oscillatory motion. Its value for use in clocks was introduced by physicists during the 15th century.



2) You can make a water clock by using water instead of sand. Take a used container with small hole at the bottom as well as at the top. Fill it with water to a specific level even as you shut one of the holes with your finger. Release the finger and *let the water stream out into a* bucket below. Note the time for the water to drain out. You have your water clock!

3) A pendulum with time period of, say, two seconds, is called a seconds pendulum as you can measure time duration of seconds easily with it.

4) Can you say when the *velocity of the bob is fastest in an oscillation? When is its velocity zero?*

# Simple Pendulums

This setup is called a pendulum. Make the stone stationary **and take it to one** side and slowly release it without pushing it or pulling it. The **pendulum** starts swinging to and fro. This to and fro motion is called an **oscillation. The motion of the swinging pendulum from A to B and back to A is called a complete oscillation.**

How much time does the pendulum take to complete one oscillation?

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This time taken is called the **period** of one complete oscillation of the pendulum. Did you have any difficulty measuring the period?

________________________________________

Now take a watch and measure the time taken for the $5^{th}$ oscillation (that is after you let 4 to and fro swings pass). So what is the time taken now by the pendulum for one complete oscillation?

________________________________________

Does the period of oscillation differ if you measure after let a given number of oscillations elapse? We look into this below.

**Experiment 3: Effect on Period and Elapse of a Number of Oscillations**

**Table 1**

| No | No. of Oscillations Elapsed (n) | Time Taken for one Oscillation (period) after the $n^{th}$ Oscillation |
|---|---|---|
| 1 | 10 | |
| 2 | 20 | |
| 3 | 30 | |
| 4 | 40 | |
| 5 | 50 | |

Did you get nearly the same period each time?

________________________________________

From this experiment write below what would you conclude about the time period?

________________________________________

________________________________________

**The Pendulum's Period**

A pendulum's period under certain assumptions can be shown (we do not prove it here) to be related to its length as below:

$T=2\pi\sqrt{l/g}$ where l is the length of the pendulum and g is the acceleration due to gravity. The symbol $\pi$ = 22/7 or 3.14 approximately, and $\pi$ (pronounced pi) is the same one that occurs in the formula for a circle's area.

Thus $T=2\pi\sqrt{l/g}$ = 0.20 x l seconds where g, the acceleration due to the earth's gravitation is taken as 980 cm/sec$^2$ and l is in cm (check the arithmetic!).

(What are some of the assumptions? The most important is that this formula is valid only for small angles that is if the bob of the pendulum is pulled aside for small angles. For large angles the time period increases with the angle of deflection of the bob from the position of rest. The other assumption in deriving the above formula is that all the mass of the bob is concentrated at one point.)

Let us check whether our measurements are correct (or whether the formula is correct!).

If l = 100 cms = 1 m, the time period is 0.20 x 10 seconds or that is the same as 2 seconds. Check it out for other lengths too!

## Simple Pendulums

This property, that every pendulum has a characteristic time period, was first discovered by the Italian scientists Galilieo in 17th Century. In the good old days clocks were made using this property of pendulums. Even today you see pendulum clocks at several places.

As you saw in the above experiment, despite measuring the time period after a certain number of oscillations, the (average) time period remains the same.

Does the length of the pendulum have to do anything with the time period? Let us explore below.

**More Pendulum Talk**

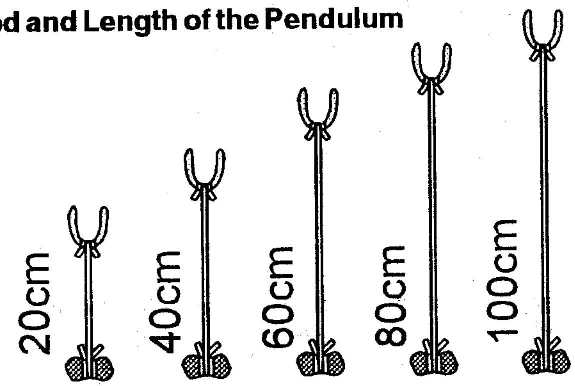
What would you do to have a *jhoola* swing way high? Increase the length of the *jhoola* or decrease it?

What material would you prefer to make the seat of a regular *jhoola* (*hitchko* in Gujarati): a wooden plank, an iron plank or any?

Assume you make two *jhoolas* on the basis of Experiment 6. You sit on one and friend on the other. You start swinging and your friend is stationary. Would you friend be able to start swinging without any effort on her own?

**If a pendulum were made of a metal rod - and was not just a bob** suspended by a string and if you were told that its time period was related to its length almost like in the formula discussed in the previous column, why would its time period increase in summer? Pendulums of old grandfather clocks were made of metal rods. So would the grand father clock go faster or slower in summer?

**Experiment 4: Time Period and Length of the Pendulum**




Again from the point where you had previously suspended the pendulum, take the one meter long pendulum and measure the time taken for 30 oscillations. Repeat three times. Find the average time taken for 30 oscillations (that is, total time divided by 3), and note it down in the appropriate column in the table below. Find the time period by dividing average time taken by 30.

Do likewise for a pendulum for 80, 60, 40, 20, cm each.

**Table 2**

| No | Length of Pendulum (cm) | Time Taken for 30 Oscillations (secs) | | | | Time Period (secs) |
|---|---|---|---|---|---|---|
| | | Trial 1 | Trial 2 | Trial 3 | Average | |
| 1 | 100 | | | | | |
| 2 | 80 | | | | | |
| 3 | 60 | | | | | |
| 4 | 40 | | | | | |
| 5 | 20 | | | | | |

If you reduce the length of the pendulum, what is the effect on its period?

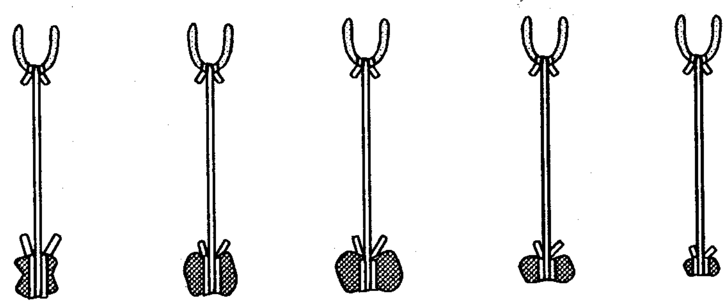
________________________________________

________________________________________

Does the time period decrease or increase with the length of the pendulum?

Now you have seen what happens to the time period with the change of the length of the pendulum. Let us see whether time period is affected with the change in the mass of the stone tied below.

**Experiment 5: Time Period and the Mass of the Stone**



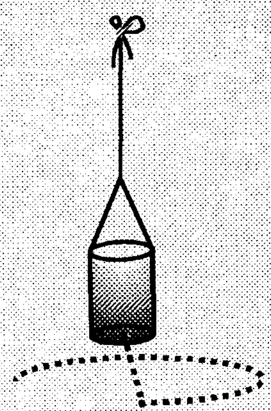

The stone used to make the pendulum is called the pendulum's bob. Keeping the length half a meter, tie stone A and measure as before time taken for 30 oscillations. Repeat this 3-4 times. Find out the average taken for 30 oscillations. Note all results in the table below. Likewise carry out the experiment with different masses B, C, D, E and F. Note the readings in the table below.

**Table 3**

| No | Stones of Different Masses | Time Taken for 30 Oscillations (secs) | | | | Time Period (secs) |
|---|---|---|---|---|---|---|
| | | Trial 1 | Trial 2 | Trial 3 | Average | |
| 1 | A | | | | | |
| 2 | B | | | | | |
| 3 | C | | | | | |
| 4 | D | | | | | |
| 5 | E | | | | | |

Did the time period differ significantly with different masses of the bob?

**Drawing with a Pendulum**



Take a metal container with a hole at the center of its bottom. Fill it with fine sand and tie strings on the container and suspend it as shown above not very far from the floor (maybe one foot from the floor surface). You will see interesting designs on the floor much of it is due to the earth's rotation under the pendulum.

In fact the scientist Foucault established the fact of earth's rotation by doing a similar experiment, only the size of the pendulum was much bigger.

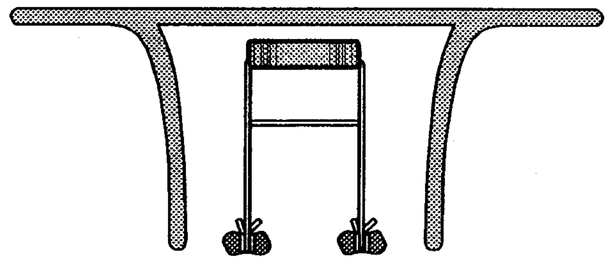
* Now since you know the formula for time period of the pendulum, what will be its time period on the moon higher or lower? On Jupiter?

* Do you see any similarity between a simple pendulum and a spring on which a mass is suspended? If you pull the spring with the mass, how does the spring move?

* Any similarity between a simple pendulum and a disk suspended from its centre (see figure below) by a steel wire and the disk allowed to rotate?

Write down your conclusions from the above experiment: the effect of the mass of the bob on the pendulum's time period.

**Experiment 6: Effect of One Pendulum on Another**



Take an one-meter long string. Tie to its ends two small stones. Take a heavy book; and use the book and a table to position the two stones as shown in the picture above. The length of both the pendulums must be equal as seen from the front. The use of the book is to ensure that the string under it does not slip or drag wit the motion of the pendulums. Tie the two pendulums in the middle with a string, as shown above, so that the string does not sag in the middle.

Now get one pendulum to swing by taking its bob a bit to the side (out of the book, not sideways). What is the effect on the other pendulum after some time?

Now adjust the book and string such that one pendulum appears to have greater length than the other. Ensure that the string in the middle tied to both the pendulums is taut (that is not sagging) and parallel to the floor. What is the effect on the shorter pendulum once the longer pendulum starts oscillating?

Make both pendulums stationary again. Let the longer pendulum start oscillating. What is the effect on the shorter pendulum once the longer pendulum starts oscillating?

What did you observe in this experiment: on two pendulums with equal length and two pendulums with unequal lengths?

**Can a Pendulum Swing Perpetually in Vacuum?**

You guessed it, or your teacher told you, that a pendulum comes to rest after sometime, because of air resistance. So then, can a pendulum oscillate forever in a vacuum?

Almost! Indeed a pendulum would swing forever if there were no air resistance. However energy was applied to start the pendulum swinging and the only reason a pendulum might continue to swing forever is if the energy in the system is never reduced. *In reality* this energy does get reduced because there would be some friction at the point where the pendulum is suspended from and there will be some heat loss because of the friction. Therefore the pendulum would lose its initial energy even in a vacuum --slowly and would not swing forever. But yes the pendulum in vacuum, in comparison to the one in your room, would quieten down much much after.

**Pendulums in the Human Body?**

Are there any parts of the human body which act like the pendulum? What would you say is its "time period"?

# 4 Unit of Living Things - Cell

**Things you Need**

**For Every Class**

Simple Microscope, Compound Microscope

**For Every Group**

Slide, Blade, onion, steel forceps, water ink, toothpick, candle, match box.

**Note for the Teacher**

Teach every student to set up the microscope.
While keeping onion peel on the slide, there should be no air gaps.
While focusing the microscope, the eye piece should not touch the slide.
While observing the slide under the microscope, the slide should not go out of focus.

**New Words**

Microscope, cell, animal cell, plant cell, cytoplasm, nucleus, cell wall, eye piece, object piece.

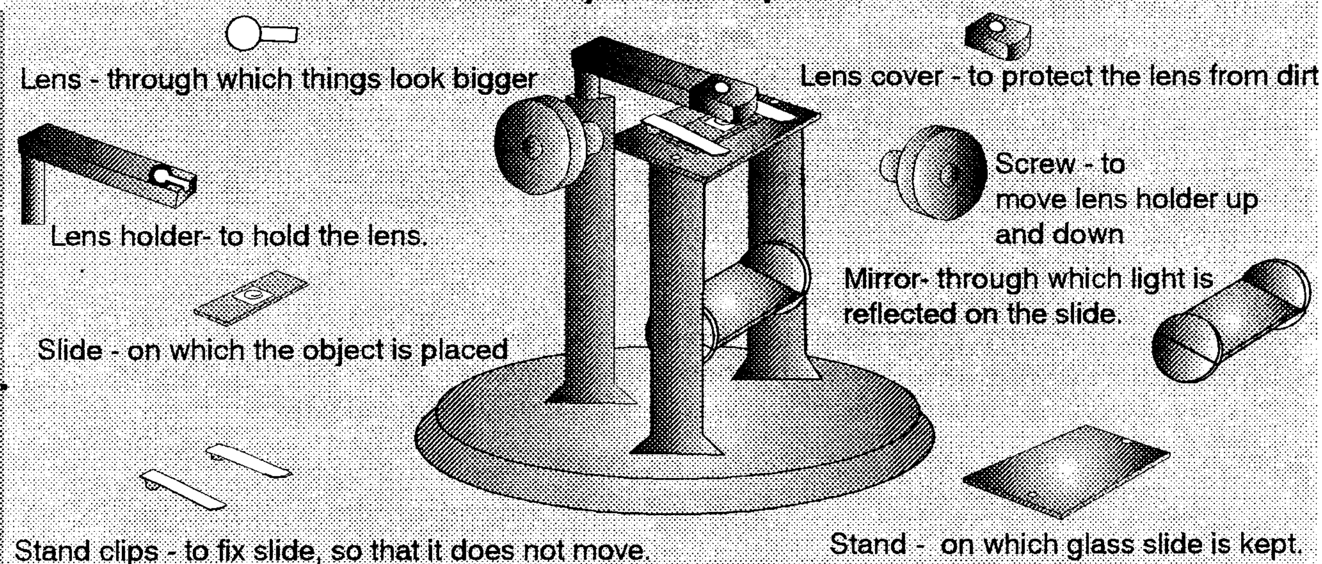
**How to Use a Microscope ?**

- Remove the lens and wipe it with a clean cloth.
- Place your eye on lens and try to observe.
- Arrange the mirror in such a way that the object is visible through the lens.
- Place the object on the slide which is to be observed.
- Place the slide on flip stand under the lens.
- Adjust the lens by turning the screw up and down.

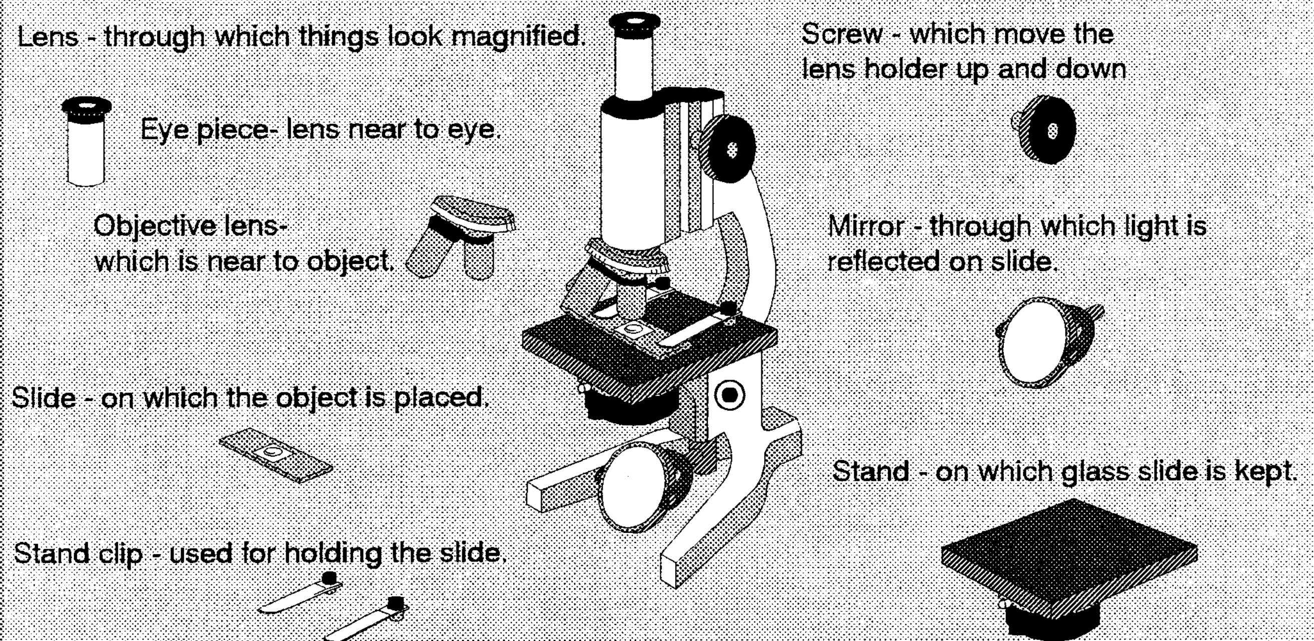
**What is a Cell**

Cell is a basic structural and functional unit of living beings. All living organisms are composed of cells. All cells arise from division of pre-existing cells. All cells are alike in chemical composition. The function of an organism as a whole is because of the combined activities and interactions of the constituent cells.

**Simple Microscope**




**Compound Microscope**

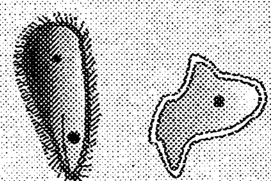


## Unit of Living Cell

Just as a building is made of bricks, all living things are made of cells. As we cannot observe the cell with the naked eye, so we will use a microscope.

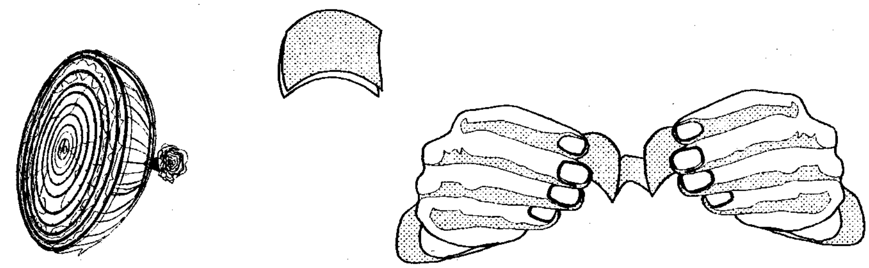
Robert Hook was the first scientist to discover the cell.

Some living things are made up of a single cell. Such organisms are called unicellular organisms, eg., amoeba, paramecium.



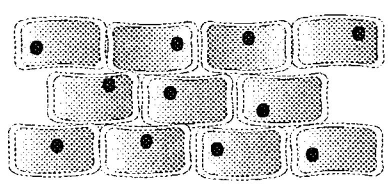
Some living things are made up of crores of cells, such organisms are called multicellular organisms, eg., human beings.

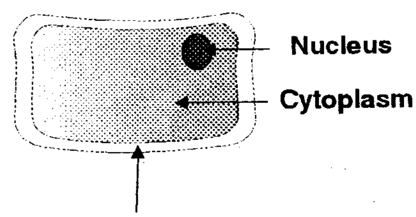
**Experiment 1: Plant Cell - the Onion Cell**



Take an onion, peel off a piece as shown in the picture. Now break this piece from the center by tugging (pulling) it apart. Remove the transparent thin layer from the inner side. Spread this thin layer on the glass slide. Put a couple of drops of ink on this peel, wash the excess ink with water, place the slide under the microscope. By adjusting the screw up and down, try to focus on the clear layers. Draw the picture of what you observe.

All systems combine to form a living body, e.g., a human body. The rectangular brick like structures you see, joined to one another, are onion cells. Try to identify different parts of the cell as shown in the picture.





## Experiment 2: Animal Cell - Cell of a Cheek Cell

### What is the difference between a plant and an animal cell?

Plant cell is larger in size and rectangular in shape whereas animal cell is smaller in size and oval in shape.

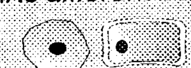
Cell wall is present in plant cell whereas absent in animal cell.

In plant cell reserve food is stored in the form of starch or oil whereas in animal cell reserve food is stored in the form of glycogen.

### What is a Living Organism made of?

The cell is a basic metabolic unit of our body.

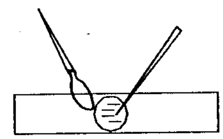
Animal cell is different from plant cell.



Cells of same type combine to perform one type of function, for example the muscular tissue.

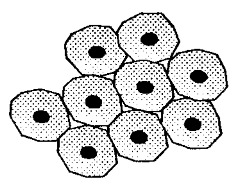
One or more group of tissues form organs, eg., stomach.

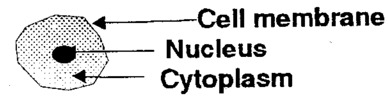
For performing specific tasks, some organs combine to form a system, eg., digestive system.



Gargle your mouth, then with the help of a washed spoon, gently rub the in side of your cheek. Then place the layer of the skin from the inside of your mouth on a glass slide and spread it with help of tooth pick. Heat the slide slightly with a candle as shown in picture. Put a drop of ink on the slide. Wash off the excessive ink with water. Place the slide under the microscope. Try to focus the cells of the cheek by adjusting with the screw of the microscope. Draw the picture of what you see through the microscope. as you observe under microscope.

Irregular rounded structures observed under microscope are cheek cells. Try to locate all the organelles of the cell and label them below. .






### Functions of Different Parts of Cell

**Cell wall:** It provides definite shape to the cell. It protects plasma membrane and internal organelles. It provides support to the cell. It helps in transporting various materials across it. It prevents drying up of cells.

**Cell Membrane/Plasma membrane:** The plasma membrane is selectively permeable. It permits the entry of certain molecules or substances to pass through it. It provides definite shape to the cell. It maintains the internal milieu of the cell.

**Cytoplasm:** It stores food material as well as it supports all the cell organelles present in the cell. It helps in exchange of materials between different cell organelles.

**Nucleus:** It controls all the activities of the cell. It plays an important role in cell division. It is responsible for transfer of hereditary characters from parents to offsprings.

# 5 Mass and Weight

**Things you Need**

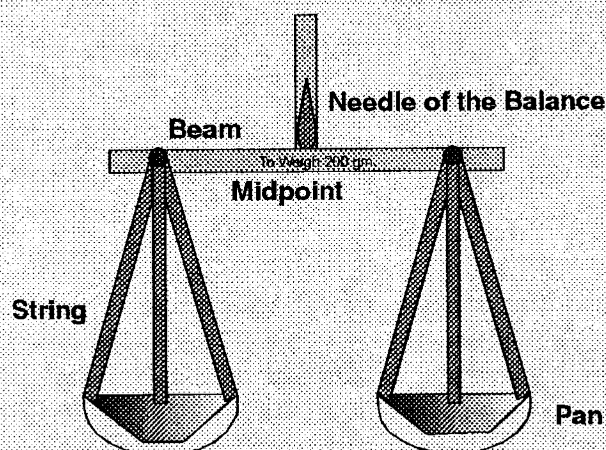
**For Every Class :** Balance, 1, 2, 5, 10, 20,100 gram weights, thread, scissor.
**For Every Group :** Wooden piece, earthen cups of equal size, ice cream cup, coconut shell, lid of box, sand, marbles, stone, pieces of broken pot, plastic pieces, measuring tape of half meter, spring balance.

**Note for the Teacher**

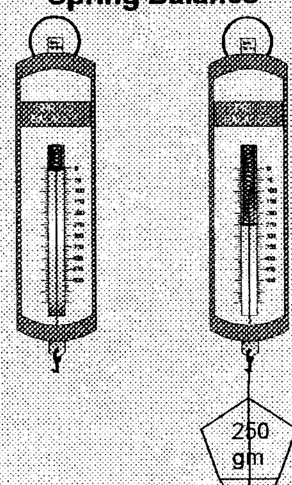
While making a balance, ensure that the length of the thread, and weight of the pans are kept equal.

**New Words**

Mass, point of equilibrium, weight, balance, needle, stick, chain, pan, axis.




**Spring Balance**




A balance is said to be true if it the obeys the following conditions:

- The beam of the balance remains parallel to the floor.
- The distance between the fulcrum and the points of suspension of the pans on the beam are equal.
- The weight of the pans and the strings from which they are suspended are equal and when held the pans stay horizontal with the needle pointing vertically.

On the stick off the balance "to weigh 200 gm" is written . That means that this balance is capable of measuring a mass of 200 gm only. More than 200 gm cannot be measured. If more mass is measured, then the axis of the balance will be disturbed. If the axis gets disturbed, then balance will not weigh correctly. 1 kilogram=1000 gram; 1 quintal=100 kilogram.

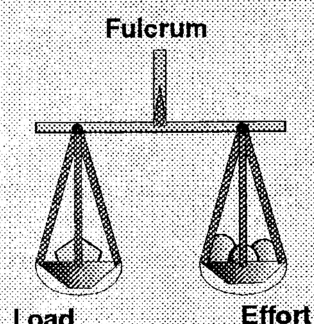
# Mass and Weight

What we normally call measuring "weight", with the kind of balance shown above, is not an object's weight but its **mass**. The amount of matter contained in an object is called its mass. The units of mass are gram (gm) kilogram (kg), etc. In normal usage, we call mass as weight -- but in science this is not correct. Weight is measured with a spring balance and is the force with which the earth's gravity pulls it downwards.

### Measurement of Mass with Balance

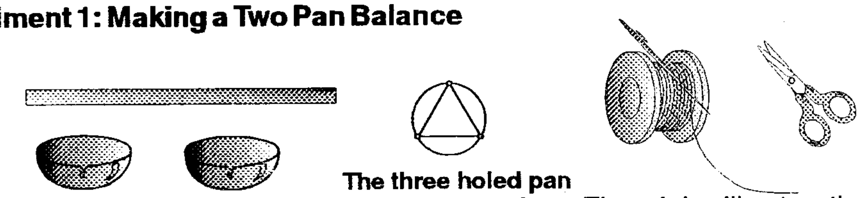
Only the mass of an object can be measured with the help of the two pan balance. Weight cannot be measured because gravitational force acts on both pans and cancels out as a common factor. For measuring the effect of gravitational force on an object, that is its weight, the spring balance is used.

The Two Pan Balance, also called a physical balance, works on the principle of a lever. It is a simple machine or lever of the first type where the fulcrum or support is between the effort and the load.



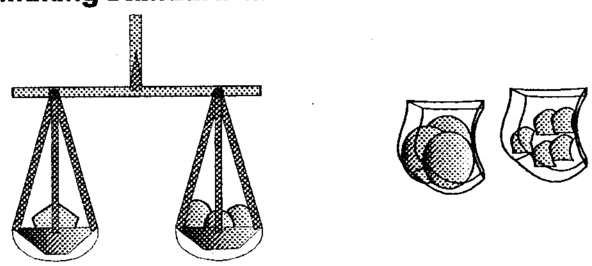

In the diagram of balance in the previous page, it is written "To Weigh 200 gm" Is this correct?

**Experiment 1: Making a Two Pan Balance**




Take a straight stick (or a foot rule) and some string. The stick will act as the beam. Make a hole in the centre of the stick and two holes on either side of it at an equal distance. The stick should stay horizontal when you suspend it with the string passed through the hole at the centre. For pans, take two equal sized bowls (or earthen cups or tin lids of containers or dried coconut shells). Make three holes in your pans as shown above at equal distance from each other. Tie the pans to the stick as shown in the picture below. Take care to see the three strings with which you tie the pan to the stick are all equal in length so that the pans stay horizontal too.

**Experiment 2: Making Standard Masses**

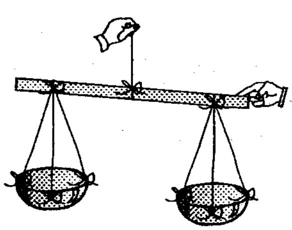


You might have seen "weights" in any shop. You are provided with objects with 1 to 100 grams written on them, in your kit. With the help of these objects you can measure mass up to 200 grams with the balance. Now to make standard masses, take pieces of broken earthen pot, brick pieces, marbles stones or sand. Select any of these material and measure its mass with the help of balance provided in the kit. Write the amount of mass of the object measured on a piece of paper and put the paper with the object in a see through plastic bag.

Normally available balances do not fulfill the conditions of a true balance. The following three defects can be removed in a defective balance to make it true.

**Experiment 3: Is your Balance True?**

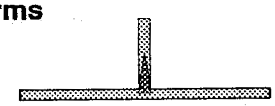
Lift the balance with the thread tied in the centre.



Press one end of stick downward and leave it aside. **Does the stick come** back to a horizontal position, that is, is it parallel to the earth's **surface? If** the stick does not stay parallel to the earth, then your balance **can have any** of these types of defects.

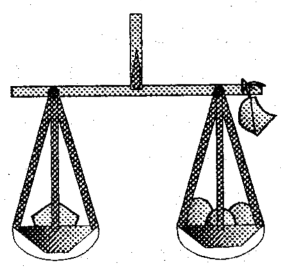
1. Defect due to unequal arms 2. Adjustment defect 3. Defect in standard masses ("weights")

**Defect due to Unequal Arms**



Examine the beam of your balance. Are the two arms of the balance equal? Measure with a scale and confirm. If not equal then adjust the central thread by moving to and fro, and make the arms equal. Now the defect in your balance is removed.

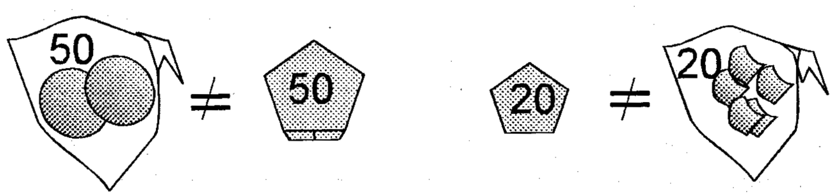
**Adjustment Defect**



Hold up an empty balance. If the stick of the balance bends towards one side, then tie a adjustment mass to the opposite side of the stick and see that the balance stays horizontal. If the stick of the balance is thicker on one side and thinner on other side or pans attached are of different masses, or there is difference in size and shape of threads used in making the balance, then there is need for this kind of adjustment

**Defect in Standard Masses**

With the help of standard masses ("weights") given in the kit, compare the the standard masses ("weights") prepared by you periodically. If required they should be modified and made equal to the standard masses given in the kit. Put equal masses in both the pans. If it balances, then it is correct and you balance can be said to be perfect.




**Measure the Correct Mass without Adjustment**

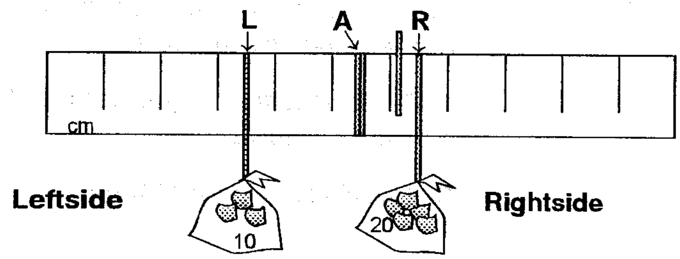
Suppose your balance has equal arms but the masses of the pans are unequal: how can you measure the correct mass without adjustment?

To measure the correct mass, put the standard mass in one pan and put the object, whose true mass we need to find, in the other pan. Note the mass of the object. Now put the object in the other pan and again balance with some standard masses. Note the mass measured. Now add both the masses you measured and divide by two. This is the true mass of the object!

Similarly, if the pans are equal in mass, but the balance has unequal arms, or weight of the pans and arms of the balance are unequal, even then with the help of mathematical equations, the correct mass can be calculated.

## Mass and Weight

### Experiment 4: Balancing



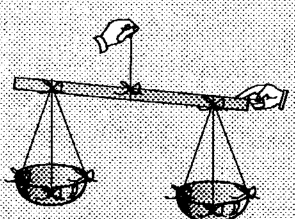

**How to find true mass even when you have balance with unequal pans and distance from the centre is also unequal?**

Put the object whose mass is to be found in the left hand pan. Balance the other pan with sand or stones.

Remove the object from the left hand pan. Balance stones, etc., in the right hand pan by adding standard masses to the left hand pan.

The total of the standard masses in the left hand pan is the mass of the original object.

Can you see why?



In case you have a spring balance whose markings are wiped out, but you have accurate standard masses, how would you find the true weight of an object in two readings?

Take a half meter scale. Tie tightly a thread around the centre, hold up the scale and observe. Does the scale tip sideways or downwards? If yes, then adjust the thread tied in centre and again balance the scale. The point A where the scale balances, that is stays horizontal, is called the **balancing point**. Mark this point on the scale. Take care that this point is not further disturbed. On the left side of scale suspend a 10 gm weight at 10 cm away from balancing point.

Now take a 20 gm weight prepared by you. Tie it on right side of the scale as shown in figure. Does your scale balance? If the scale does not balance, then adjust the weight tied on right side of scale to and fro and balance it.

Note the distance LA in the table given below. Now move the weight tied on the left hand side to 15 cm away from the balancing point. Now balance the weight on the right hand side and note down in the table the distance AR .

Now on the left hand side of the scale tie 20 gram weight at 8 cm away from the balancing point. On right hand side how far will you tie the 40 gram weight so that the scale balances? Note down this distance in the table. Now on the left hand side tie the same weight at 16 cm away from balancing point. Note down the distance on the right hand side where 40 gram weight get balanced. Similarly, fill in the blanks in the table by actually balancing..

| No | Left Side | | | Right Side | | |
|---|---|---|---|---|---|---|
| | Mass in gms | Distance LA in cm | Distance x Mass in Left Pan | Mass in gms | Distance RA in cm | Distance x Mass in Right Pan |
| 1 | 10 | 10 | 100 | 20 | | |
| 2 | 10 | 15 | 150 | 20 | | |
| 3 | 20 | 8 | 160 | 40 | | |
| 4 | 20 | 16 | 320 | 40 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | 30 | 15 | 450 | 30 | | |
| 6 | 30 | | | 20 | 15 | 300 |
| 7 | 40 | | | 30 | 12 | 360 |
| 8 | 40 | | | 60 | 06 | 360 |
| 9 | 50 | | | 10 | 20 | 200 |
| 10 | 50 | | | 60 | 10 | 600 |

Do you notice any relationship between the product of the mass on the left pan and distance LA of the left pan from the fulcrum, and the product of the mass on the right hand pan and distance RA?

On this basis we can write equation of balance

**Equation of the Balance**

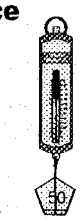
Mass in left hand pan x distance of left hand pan from fulcrum =
Mass in right hand pan x distance of right hand pan from fulcrum

Note: When we say distance of left hand pan from fulcrum, we mean distance from the *point* of suspension of the pan to the fulcrum, etc.

**Measurement of Weight**

In the lesson on speed and forces, we learnt that gravitational force of earth acting on the object is the weight of object and it can be measured with a spring balance. Spring balance shows the weight of the objects by stretching downward. This stretching force is measured in kilogram weight or gram weight units.

**Experiment 5: Measurement of Weight with a Spring Balance**




Take a spring balance given in the kit. Measure 50 gram weight prepared by you on spring balance. What is the reading on the spring balance?

**The units of** mass of things we are weighing is in grams or kilograms. The **units of the corresponding** weights will be in gram weights or kilogram **weights.**

**More on Mass and Weight**

The mass of an object (measured in kg or gm ) will be the same no matter where in the universe that object is located. Mass is never altered by location, the pull of gravity, speed or even the existence of other forces.

On the other hand, the weight of an object will vary according to where in the universe the object is. Weight depends upon which planet is exerting the force and the distance the object is from the planet. Weight, being equivalent to the force of gravity, is dependent upon the value of g (acceleration of gravity). On Earth's surface, g is 9.8 $m/s^2$ (often approximated to 10 $m/s^2$). On the moon's surface, g is 1.7 $m/s^2$. Go to another planet, and there will be another g value. In addition, the g value is inversely proportional to the distance from the center of the planet. So if g were measured at a distance of 400 km above the earth's surface, you would find the value of g to be less than 9.8 $m/s^2$. Therefore your weight be less on a mountain!

The unit of weight is Newtons. On earth if your mass is 50 kg, your weight will be 500 Newtons approximately

However in this chapter we have mentioned the units of weight as gram-weight and kg-weight.

# Mass and Weight

1 kilogram weight = 1000 gram weight. Similarly, objects written in gram weight can be written in kilogram weight. Similarly weights written in kilogram weight can be converted into gram weight.

In the same way, weigh different substances with the help of spring balance and write in the table.

| Mass of Object in gm | Weight of Object in gm wt |
|---|---|
| | |
| | |
| | |
| | |
| | |

Based on the above experiments, answer the following questions:
What will be the weight an object having mass of 1 kilogram?

What will be the weight (in gram weights) of an object having mass of 1 kilogram?

What will be the mass of an object having a weighing 5 kilogram weights?

What will the mass in gram and kilogram of an object having weight of 2000 gram weights?

**Which is Heavier?**
Place a beaker of water, full up to the rim on one pan of a balance. On the other pan, put another beaker full of water, also up to the rim, but with piece of wood floating on it. Which of the two is heavier?

Take a glass of water. Put it on one of the pans, and put a weight next to it. Balance the scales. Then drop the weight next to the glass in it. What happens to the scales?

You may like to revisit these problems, after you have read the chapter on why things float.

### Weights of Falling Bodies

You may have noticed if you have gone on a giant wheel, when you come down you feel lighter - in fact very light. The same thing happens if you go down a lift.

This sensation is caused by *weightlessness*. At the very first moment, the lift starts to go down, you still have not acquired its velocity, your body exerts hardly any pressure on the floor of the lift, and therefore weighs very little. An instant later this funny sensation is gone, as your body now seeks to fall faster than the smoothly running lift; it exerts a pressure on the floor of the lift, regaining its full weight.

You can see this in another way. Tie a weight to the hook of a spring balance, and observe the pointer as you quickly lower the balance. The pointer will fail to register the full weight -- it will weigh much less! If the balance were to fall freely and you were able to note the reading, you will see it is zero! A falling body is weightless!!

# 6 Elements and Compounds

**Things you Need**

**For Each Group**

Marbles of different colours, a dish, chalk, cards given on the last page of the book.

**Note for the Teacher**

Many concepts of this lesson are invisible, abstract and imaginary. But they are exciting and have proved very useful. Explain your students that scientists have worked since ages to prove some of these concepts and they may not be understood easily the first time.

**New Words**

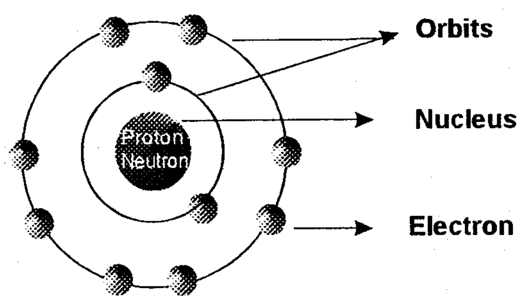
Atom
Molecule
Model
Concept
Nucleus
Proton
Neutron
Electron
Orbit / Shell
Sub shell
Element
Compound
Inert gases
Periodic Table

In the lesson States of Matter in Class 6, we learnt that substances are made up of extremely small particles called atoms and molecules. We will discuss more about atoms and molecules in this lesson.

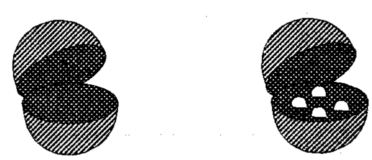
**Atom**

Atoms are so small that we cannot see them neither with our naked eyes nor through a microscope.They are so minute that approximately **6,00,00,00,00,00,00,00,00,000** atoms can be accommodated on a small space like a pin-top. You would be very curious to know the structure of such an atom. Let us understand the structure of an atom.

**Structure of Atom**




From the 6th century BC, Hindu, Buddhist and Jain philosophers in ancient India developed the earliest atomic theories. The first philosopher who formulated ideas about the atom in a systematic manner was Kanada who lived in the 6th century BC. Another Indian philosopher, Pakudha Katyayana who also lived in the 6th century BC propounded ideas about the atomic constitution of the material world. Indian atomists believed that an atom could be one of up to six elements, with each element having up to 24 properties.



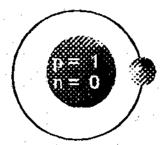
In modern times, many scientists tried to speculate (tried to imagine) the structure of an atom. Ideas of Dalton, Rutherford, and Bohr were some of the earliest theories about atomic structure. Some of their ideas are still valid; others have been long revised. One of the earliest models of the structure of atom was that it was like the solar system: just as planets revolve round the sun, negatively charged electrons revolve round the nucleus of the atom.

So let us play a game today to understand the structure of atom. For this we will *assume* atoms to be spherical. The center of such a spherical atom is the nucleus. The nucleus contains particles called positively charged protons and neutrons which have no charge.

Electrons revolve round the nucleus in orbits. The number of orbits are decided from the number of electrons it possesses. The inner most orbit of the atom can hold only two electrons in it. The second orbit can hold a maximum of eight electrons. The next orbits hold 8,18 and 32 electrons respectively. But we shall study only up to 2nd or 3rd orbit. The stability of an atom is determined by the number of electrons in its outermost orbit. The number of electrons in an atom is equal to the number of protons present in its nucleus.( ...unfortunately, the picture of an **electron orbiting a nucleus** just isn't the best way to describe an atom. But for our purpose we will go ahead with it.).

**Game 1**

Observe the following diagram of an atom.




Hydrogen atom

How many protons are there? How many neutrons are there? How many electrons are there?

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You have to make such a diagram on the floor of your class. Here we shall use a dish (given in the kit) to represent a nucleus instead of drawing a circle. Now you just have to draw three circles outside the dish as its orbits. You have been given three different coloured marbles in your kit. Now decide the separate colours of marbles to be used as proton, neutron, and electron with the help of your teacher.

Now where will you place the protons and neutrons?

---

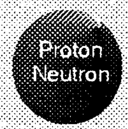
Where will you place the electrons?

---

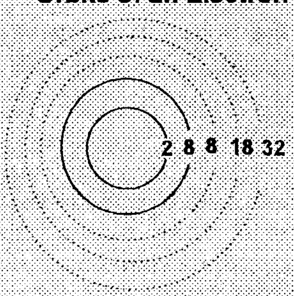
So now we have made a similar structure of an atom as shown in the figure. More than 100 such distinct atoms, called elements, have been found in nature. Each element has a name and a short form symbol. Eg. Oxygen - **O**, Hydrogen - **H**, Carbon - **C**

Within a single element, the number of neutrons may also vary: atoms with same number of protons but different number of neutrons are called isotopes of the same element. See left column for more on isotopes.

**Nucleus**

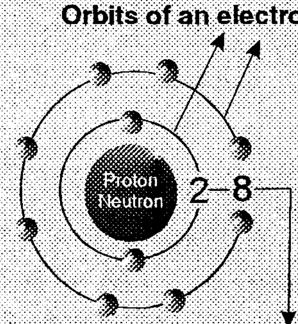



**Orbits of an Electron**




**Electron**

**Orbits of an electron**




**Capacity to hold the electrons**

**On Isotopes**

The chemical properties of isotopes are the same, although the physical properties of some isotopes may be different. Some isotopes are radioactive- meaning they "radiate" energy as they decay to a more stable form, becoming perhaps another element. Another example is oxygen, with atomic number of 8 can have 8, 9, or 10 neutrons.

## Elements and Compounds

Atoms are electrically neutral if they have an equal number of protons electrons. Electrons that are furthest from the nucleus may be transferred other nearby atoms or even shared between atoms. Atoms which have either a deficit or a surplus of electrons are called ions.

Now study the following table, which displays the name, symbols, number of neutrons and protons in an atom. Let us make the structure of all the elements as given in the table. Also remember to complete the incomplete parts of the table.

**Table 1**

| Name of the element | Symbol | No. of Protons | No. of Neutrons | No. of Electrons | No. of element in the outermost orbit |
|---|---|---|---|---|---|
| Hydrogen | H | 1 | 0 | | |
| Helium | He | 2 | 2 | | |
| Lithium | Li | 3 | 4 | | |
| Beryllium | Be | 4 | 5 | | |
| Boron | B | 5 | 6 | | |
| Carbon | C | 6 | 6 | | |
| Nitrogen | N | 7 | 7 | | |
| Oxygen | O | 8 | 8 | | |
| Fluorine | F | 9 | 10 | | |
| Neon | Ne | 10 | 10 | | |
| Sodium | Na | 11 | 12 | | |
| Magnesium | Mg | 12 | 12 | | |
| Aluminum | Al | 13 | 14 | | |
| Silicon | Si | 14 | 14 | | |
| Phosphorus | P | 15 | 16 | | |
| Sulphur | S | 16 | 16 | | |
| Chlorine | Cl | 17 | 18 | | |
| Argon | Ar | 18 | 22 | | |

Now answer the following question on the basis of this table.

What is the number of electrons in each element? Is it equal to the number of protons or is it different? Why?

______________________________

What is the number of protons in hydrogen atom?

______________________________

**The number of protons in any atom is called its atomic number.**

What is the number of neutrons in the hydrogen atom?

______________________________

______________________________

**Periodic Table**

All elements can be arranged in six periods. The number of elements in these six periods are 2,8,8,18, and 32.There is a remarkable similarity in physical and chemical properties in each vertical column of the periodic table. Except for the first period, each period starts with a highly reactive alkali metal lithium, sodium, potassium, and so on)and ends at the right with an inert gas.

Now add the number of proton and neutron in the hydrogen atom.

**The sum of the number of protons and neutrons in any atom is known as its atomic mass.**

Write the atomic numbers and atomic masses of all the given element given here in table.

**Table 2**

| Name of the element | Atomic number | Atomic mass no. |
|---|---|---|
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Protons in an atom have positive(+) charge. Neutrons do not have any charge. Electrons revolving in orbits are negative ( - ) charged.

Try to recall what is the maximum number of electrons accommodated by the first and second orbit ?

________________________________________

________________________________________

Now let us say something about a molecule.

**Molecule**

At times some definite number of atoms combine together to form a molecule. At times molecules are made up of the same type of atoms and sometimes two or more different types of atoms.

### Some Rules of the Language of Chemistry

Each type of atom is depicted by its fixed symbol, e.g.,Oxygen by **O.**

The number in front of the element shows the total number of atoms in it, e.g., **2 H** means two distinct atoms of hydrogen

A small number written as subscript after the symbol of that element depicts total number of atoms in a molecule of that element.

e.g., $\mathbf{H_2}$ means hydrogen molecule comprised of 2 atoms of hydrogen.

### Some Basic Properties of Atoms

1) Most atoms in our daily life are stable: otherwise everything including us would keep changing.

2) Atoms combine with each other; they stick together to form stable molecules and/or rigid solids. An atom is mostly empty space but one can stand on the floor made up of atoms without falling through it.

3) Atoms emit and absorb light

4) Atoms are like spinning magnets: they have angular momentum like spinning tops and magnetism like magnets.

5) Atom exist only at specific energy levels (that is like a staircase and not a ramp): they emit or absorb light when they shift between energy levels.

**We saw earlier that similar type of atoms of one element combine to form molecules.**

E.g. Two atoms of oxygen combine to form a molecule of oxygen.

$$O^{-2} \quad + \quad O^{-2} \quad = \quad O_2$$

Oxygen atom + Oxygen atom = Oxygen molecule.

The molecular formula for oxygen molecule would be $\mathbf{O_2}$.

Two atoms of hydrogen combine to form a molecule of hydrogen. Then what would be the formula for hydrogen molecule ? **2H or $H_2$** ?

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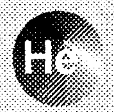
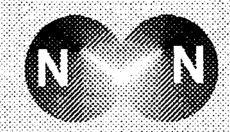
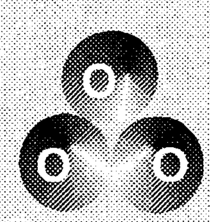


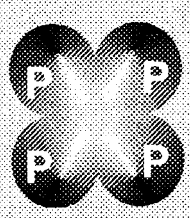

Helium molecule




Nitrogen molecule




Oxygen molecule




Phosphorous molecule

You are given symbols of some elements and their number of atoms in contained by them in Table 3. Write their molecular formula.

**Table 3**

| Name of Element | Symbol | No. of Atoms in a Molecule | Molecular Formula |
|---|---|---|---|
| Helium | He | 1 | |
| Nitrogen | N | 2 | |
| Carbon | C | 4 | |
| Phosphorous | P | 4 | |
| Sulphur | S | 8 | |
| Chlorine | Cl | 2 | |

Now once again see Table 1. Which elements have their outermost orbits completely filled ?

______________________________________________

Atoms of such elements neither donate nor accept any more electrons in their outermost orbits.

**They are therefore known as inert elements. These inert elements do not take part spontaneously in any chemical reactions.**

Atoms of rest of the elements have electrons with incomplete outermost orbits. Atoms of such elements are always trying to complete their outermost orbits. They try to stabilize themselves either by giving out or accepting minimum number of electrons from the outermost orbits.

### Important Terms

- **atom** - smallest piece of an element that keeps its chemical properties
- **compound** - substance that can be broken into elements by chemical reactions
- **electron** - particle orbiting the nucleus of an atom with a negative charge (mass = $9.10 \times 10^{-28}$ grams)
- **element** - substance that cannot be broken down by chemical reactions
- **ion** - electrically charged atom (i.e., excess positive or negative charge)
- **molecule** - smallest piece of a compound that keeps its chemical properties (made of two or more atoms)
- **neutron** - particle in the nucleus of an atom with no charge (mass = $1.675 \times 10^{-24}$ grams)
- **nucleus** - dense, central core of an atom (made of protons and neutrons)
- **proton** - particle in the nucleus of an atom with a positive charge (mass = $1.673 \times 10^{-24}$ grams)

Note: $10^{-24}$ means 0.000000000000000000000001 - that is 23 zeroes before the last 1. That is one divided by a thousand crore crore crore.

**Valency is defined as the number of electrons lost, gained or shared by the atoms during chemical reactions.**

E.g. We have an atom of hydrogen. Now how many electrons are there in its outermost orbit?

________________________________________

How many electrons are needed to complete the outermost orbit and thereby stabilizing it?

________________________________________

Here hydrogen has one electron in it's outermost orbit. It requires one additional electron to form a stable configuration. Hence in this case if hydrogen atom accepts one electron then it forms a negatively charged ion. But If it donates one electron then it will form a positive ion and can stabilize its orbit.

Now see the number of electrons in the outermost orbit of the structure of sodium atom made by you. How many electrons are there in the outermost orbit?

________________________________________

Thus sodium atom will either have to lose **1** electron or gain **7** electrons in order to stabilize the outermost orbit. Now it has to do minimum give and take of electrons. (Lot of energy is required to gain 7 electrons. It is not possible to provide so much energy in natural conditions. Whereas it takes very less energy to donate an electron.) So it would like to attain positive charge by losing just **1** electron. Thus sodium would attain **+1** valency.

Similarly find out the valencies of other elements in the same way and fill in the table.

**Table 4**

| Name of the Element | Valency |
|---|---|
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### Why are inert gases Inactive ?

We know that when the outermost orbit of any atom is completely filled, it remains stable. In such cases, these atoms do not take part in chemical reaction. The outer most orbits of helium, neon, argon, etc. are completely filled. Therefore they do not take part in chemical reactions easily. Therefore they are called inert or "noble" gases.

Such gases do not catch fire as they do not take part in chemical reactions. Because of its inertness, these gases are used in different types of bulbs and lighting systems in mines.

### How are electrons organized around the nucleus?

All atoms would like to attain electron configurations like noble gases. That is, have completed outer shells. Atoms can form stable electron configurations like noble gases by: losing electrons, sharing electrons or by gaining electrons.

For a stable configuration each atom must fill its outer energy level. In the case of noble gases that means eight electrons in the last shell (with the exception of He which has two electrons).

Atoms that have 1, 2 or 3 electrons in their outer levels will tend to lose them in interactions with atoms that have 5, 6 or 7 electrons in their outer levels. Atoms that have 5, 6 or 7 electrons in their outer levels will tend to gain electrons from atoms with 1, 2 or 3 electrons in their outer levels. Atoms that have 4 electrons in the outer most energy level will tend neither to totally lose nor totally gain electrons during interactions.

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An atom of any element can exchange its electron in order to stabilize its orbit when some other atom of another element is available to exchange its electron for stabilizing its own orbit.

Thus the atom of one element becomes positive after releasing an electron and simultaneously the other atom of reacting element becomes negative by accepting the electrons. The two independently existing atoms together make a molecule of a compound.

**Two or more different types of atom combine together to form new compound.**

E.g. Sodium atom has +1 valency, Chlorine atom has -1 valency. They combine together to form a molecule of sodium chloride which is a compound. The chemical equation for this can be written as:

$$Na^{+} + Cl^{-} = NaCl$$

At times it happens that no atoms of elements are present that can donate or exchange same number of electrons required by the other reacting atom. In such case the atoms of the element combine with more than one atoms of the other elements and form the compound.

E.g. Oxygen atom has minus 2 valency, i.e., it requires two electrons to stabilize it's outermost orbit. Valency of hydrogen is +1 that means it can donate or give only 1 electron. Under such circumstances oxygen will combine with two separate atoms of hydrogen and fulfill its requirement. Thus, two atoms of hydrogen and one of oxygen combine together to form a water molecule.

The molecular formula of water can be written as,

$$H^{+1} + H^{+1} + O^{-2} = H_2O \text{ i. e., } 2H^{+1} + O^{-2} = H_2O$$

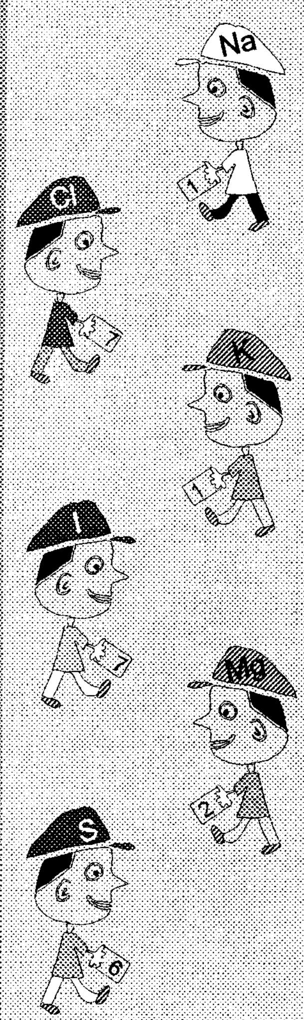
The water molecules possess different properties than the atoms of hydrogen or oxygen. So let us play a game to form a new compound on the basis of valency.

**Game 2**

Cut out the cards present on the pack cover from the book of any child of your group. Now distribute this cards among all members of your group. Now let any member of the group show any one card from her cards. The other member will place the card to form a compound considering the valency of the card played by the previous person. she will keep that pair of cards with her. Now she will play yet another card. If the next person does not have the card to form a compound, she will say "pass". Then the turn would go to next person. Thus each person will make her own card compound and remember that of others too.

After completing the formation of compounds the member making the last card compound will ask for specific compounds made by some other students. Suppose that compound is not found with him than saying pass he will start asking for the compound card. At the end of the game one who has all the compound card would be declared the winner.

Which of the following atoms would combine with another different atom to form a molecule of a compound. Here each atom is present holding a card with its number of electrons in its outermost orbit.




**Reality Check**

1) Your model in Game 1 showed the basic structure of the atom you chose. But in a real atom, the electron's orbit is spherical, ellipsoidal, butterfly- like, and other shapes around the nucleus. Also, the protons and neutrons in an actual atom are about 2000 times more massive than the electrons. And finally, an atom's electron orbits have a radius thousands of times greater than the nucleus. That would be almost impossible to show in a model!

2) Because atoms are so small, no one can see them. And if we try to look at them (like with a very powerful microscope), we usually end up ruining them in the process, so we can never see them "as they are."

For this reason, we just can't say exactly where the electron is, as it moves about the nucleus. This makes the models involving orbits, whether circles, or ellipses, just plain wrong, because the orbits are pretty specific about the electron's whereabouts.

The modern physics of Quantum Mechanics doesn't tell us just where the electron is (like in the orbits), it just tells you where the electron is **most likely to be.**

# 7 Acid, Base and Salt

**Things you Need**

**For Each Class**

Beaker, tamarind, lemon, soap cake, soda bicarbonate, curd, sugar, sodium hydroxide, hydrochloride acid, salt, tomato, laxative ("purgolax").

**For Each Group**

Test tube, test tube stand, red and blue litmus papers, dropper, bowl.

**Note for the Teacher**

Please take care to see that no child tastes the substances and chemicals used in the experiment.

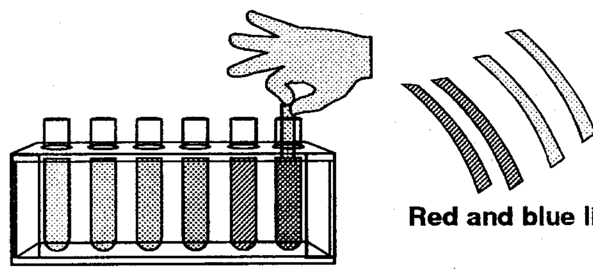
Solutions to be used in Experiments 2 and 3 will have to be prepared in advance by teachers.

Other routine precautions for handling chemicals should also be kept in mind.

**New Words**

Acid
Base
Salt
Neutral substance
Neutralization
Sodium hydroxide (caustic soda)
Hydrochloride acid
Phenolphthalein
Litmus paper
Indicator

Substances that we use in our daily life have specific (definite) characteristics. The reactions between two or more substances take place due to specific properties of each substance. In this chapter, we will study some specific properties of some substances and their reactions with each other.



**Red and blue litmus papers**

**Experiment 1: Verification of Substances**

Collect substances like tamarind, lemon, soap cakes, soda bicarbonate, curd, sodium hydroxide, hydrochloride acid, salt, tomato juice, sugar, etc. Place them in different test tubes and make their solutions adding water to each of these test tubes. Label them properly. Dip red and blue litmus papers (from the given kit) into the solutions one after the other and observe the effect of the colour of the solution. Note down your observations in the following table.

**Table 1**

| No. | Name of the Substance | Effect on Red Litmus Paper | Effect on Blue Litmus Paper |
|---|---|---|---|
| 1 | Tamarind solution | | |
| 2 | Lemon | | |
| 3 | Soda bicarbonate solution | | |
| 4 | Curd | | |
| 5 | Caustic soda solution | | |
| 6 | Lime water | | |
| 7 | Hydrochloride acid | | |
| 8 | Salt solution | | |

| | | | |
|---|---|---|---|
| 9 | Soap solution | | |
| 10 | Sugar solution | | |

Now answer the following questions on the basis of Table 1.
List out substances which turn blue litmus paper into red.

______________________________________________

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**Substances that changes blue litmus paper into red possess the characteristics of acids. Such substances are called acidic substances.** Now list out such substances from the table that turn red litmus paper into blue.

______________________________________________

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**Substances that turn red litmus paper to blue possess the characteristic of a base. Such substances are called basic substances or alkaline.** Now make a list of substances that do not have any effect on litmus papers.

______________________________________________

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**Substances that do not result in change in colour of blue or red litmus papers are neither basic nor acidic. Such substances are called neutral substances.** List down all the substances in Table 1 and Table 2 as per their nature.

**Table 2**

| Acidic Substances | Basic Substances | Neutral Substances |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

We learnt that due to the acidic or basic properties of substances they react with litmus paper resulting in change of colour of the litmus paper. Let us further understand the reactions taking place between acids and bases through some experiments. (**Instruction to the Teacher**: The teacher will have to prepare solutions for the ensuing experiments.)

The word acid has its roots in Latin which means sour. Thus sour substances are called acidic substances. Some acidic substances are available freely in nature, e.g., juices of lemons, grapes, etc. Some of the acidic substances are formed due to the chemical reactions of minerals present in the crust of earth, e.g., sulphuric acid, nitric acid, etc.

| Acidic Substance | Name of acid contained by them |
|---|---|
| Tamarind | Tartaric acid |
| Citrus fruits e.g. Orange, lemon | Citric Acid |
| Tomato | Oxalic Acid |
| Vinegar | Acetic Acid |
| Curd | Lactic Acid |
| Pulpy fruits e.g. apple | Myelic Acid |

# Acid Base

| Name of Indicator | Colour in Acid |
|---|---|
| Litmus | Red |
| Methyl orange | Orange |
| Phenolphthelein | Colorless |
| Red cabbage juice | Red |

**Uses of Acids**

Nitric acid is used to manufacture fertilizers like ammonium nitrate and calcium ammonium nitrate.

Sulphuric acid is used in making dyes and batteries.

Hydrochloric acid is used to purify simple salts. It is also useful in the process of galvanization as a purifier.

Precaution: Please hold the sodium hydroxide tablet with spoon and not with your fingers. Touching sodium hydroxide with fingers produces a burning sensation. If this happens wash your hands with clean cold water. Concentrated hydrochloride acid also produces burning sensation. Hence it should also be used cautiously.

**Method of Preparing Sodium Hydroxide Solution**

Dissolve approximately 20-25 tablets of sodium hydroxide in 500 ml of water to prepare a dilute solution of sodium hydroxide.

**Making Solution of Dilute Hydrochloric Acid**

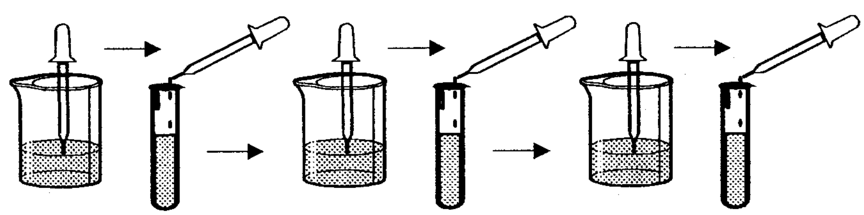
Dissolve approximately half a test tube of concentrated hydrochloride acid in 500 ml of water.

**Making Clear Lime Water**

Dissolve half a tube of lime (calcium hydroxide) in about a quarter glass full of water and stir. Allow it to settle and then decant the upper clean portion of that solution.

**Making Pink Solution of Phenolphthalein**

Dissolve "purgolax" tablets in half a glass of clear lime water. This solution will turn pink as lime is base. This is a kind of pink phenolphthalein solution. We will now use this an indicator. This is how.



Sodium hydroxide Phenolphthalein Hydrochloric acid

**Experiment 2: Neutralisation -1**

Take a solution of phenolphthalein, sodium hydroxide and dilute hydrochloric acid in a clean test tube. Label them appropriately. Now put ten drops of sodium hydroxide in another clean test tube with the help of a dropper. Add 2-3 drops of pink phenolphthalein solution into it. Observe the colour of the solution. Then add dilute solution of hydrochloric acid drop by drop; count the number of drops and shake the test tube. Stop adding anymore drops of hydrochloric acid as soon as the pink colour of the solution vanishes. How many drops of hydrochloric acid were needed for the pink colour to vanish?

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______________________________

Is this colourless solution acidic, basic or neutral ? Test with the help of litmus paper before you write your answer.

---

Bases are oxides and hydroxides of metallic elements. Bases when dissolved in water are called **Alkalies.**

All alkalies are bases but not all bases can become alkalies.

Substances formed by reaction of metallic elements with oxygen are basic in nature. This oxides when dissolved in water becomes base. Bases have astringent(bitter) taste and they are sticky to touch.

| **Basic Substance** | **Name of the base contained in it** |
|---|---|
| Baking soda | Sodium bicarbonate |
| Lime paste | Calcium carbonate |
| Washing soda | Sodium carbonate |

We can do this same experiment in an other way also.

**Experiment 3: Neutralization - 2**

Get some phenolphthalein solution, dilute solution of sodium hydroxide and hydrochloric acid from your teacher. Put ten drops of hydrochloric acid in a clean test tube. Add 2-3 drops of pink phenolphthalein solution. Does the colour of the solution in the test tube change as in the previous experiment?

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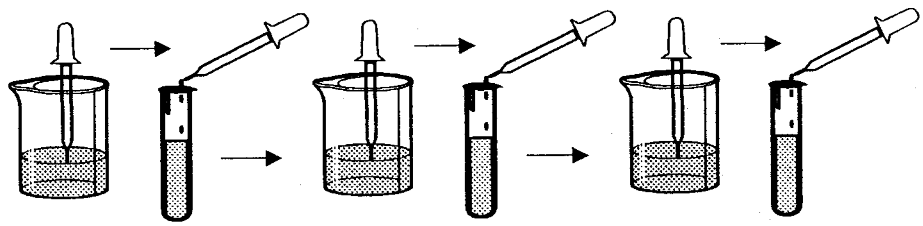
Add dilute solution of sodium hydroxide drop by drop. Count the number of drops, shake the test tube well and stop adding drops of sodium hydroxide when the solution become light pink.



**Sodium hydroxide** **Phenolphthalein** **Hydrochloric acid**

Note how many drops of sodium hydroxide solution are needed to turn it pink.

---

Would this light pink solution be acidic, basic or neutral? Verify by litmus paper and write your answer.

---

How many drops of hydrochloric acid were required to neutralize ten drops of sodium hydroxide?

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How many drops of sodium hydroxide are required to neutralize ten drops of hydrochloride acid ?

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Thus we saw that the new substances produced by the reaction of definite proportion of acid and base is neutral. The equation of the above reaction could be written as under.

$$H^{+1}Cl^{-1} + Na^{+1}\ OH^{-1} = NaCl + H_2O$$

**Hydrochloric acid+Sodium hydroxide = Sodium chloride+Water**

As a result of the reaction between acid and base, both of them lose their original properties. The new substance, obtained along with water as end product, is neutral in nature. Such a substance is called 'salt'. Substances taking part in such reactions lose their own properties and produce new substances with altogether different properties. Such a reaction is called chemical reaction.

| Name of the indicator | Colour in base |
|---|---|
| Litmus | Blue |
| Methyl orange | Yellow |
| Phenolphthalein | Pink |
| Red cabbage juice | Blue |

**Uses of Bases**

Bases are used as antacids.

Sodium hydroxide is used to make soap, detergent powder, paper pulp, and rayon.

Bases are used as indicators in laboratory.

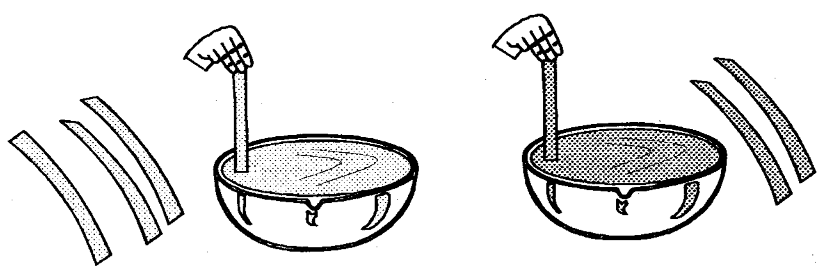
Calcium hydroxide is useful to make plaster, and in making bleaching powder.

In the above experiment we used phenolphthalein as an indicator. Now in the ensuing experiment we shall make indicators using easily available substances from the surrounding.

**Experiment 4: Making an Indicator**

Take a quarter spoon full of turmeric powder. Make a thick batter out of it by adding required quantity of water. Dip some strips of an ordinary paper into the batter and dry. The turmeric paper indicators are ready for you. Yellow turmeric paper turns red on being dipped in base.

How then would you make red turmeric paper? Recall the method of making pink solution of phenolphthalein.



What kind of solution will have to be made - whether acidic or basic - to prepare red turmeric paper?

Make batter of turmeric with lime water. Add strips of paper in this solution and make red turmeric paper like the yellow one.

## Acid Base

The reaction between acid and base results in the formation of a salt. In this reaction the metallic atom of base replaces hydrogen atom of acid and combines to form salt. The displaced hydrogen atom combines with hydroxyl ion of base and forms water. All salt solutions possess properties of a neutral solution. But all neutral solutions are not necessarily salt solution.

Salts obtained made from sulphuric acid are called sulphates. E.g. Calcium sulphate, $CaSo_4$

Salts obtained from nitric acid are called nitrates. E.g. Calcium nitrate, $Ca(NO_3)_2$.

Salts obtained from hydrochloric acid are known as chlorides. E.g. Calcium chloride, $CaCl_2$

Salts from phosphoric acid are known as phosphates. E.g. Calcium phosphate, $Ca_3(PO_4)_2$.

Salts from carbonic acids are called carbonate. E.g. Calcium carbonate, $CaCO_3$

Verify the following by dipping both red and yellow turmeric papers in acidic and basic substances in turn.

*What is the nature of the substance that turns red turmeric paper yellow ?* Acidic or basic ?

______________________________________________

What is the nature of the substance that turns yellow turmeric paper red? Acidic or basic ?

______________________________________________

What is that substance called which does not have any effect on either red or yellow turmeric papers ?

______________________________________________

We can also make indicators with different types of flowers.

Pluck petals of the same type of flower and rub them against ordinary paper. Now cut two strips from this paper. Dip one in an acid and the other in a base. In which solution does it show change in colour ? Acid or base ?

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If the colour of a strip changes in the base we would add that flower extract in base and make a new coloured indicator. In which solution, this new coloured indicator made from base, will change its colour into? Acid or base ?

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In order to make a different coloured indicator, in which solution should we add the flower extract if the strip changes its colour in acid ?

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In which solution (acid or base) will this new indicator made from acid will change its colour ?

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In the same way from which other flowers could we make indicators?

# 8 Chemical Reactions

In the chapter on acids and bases, you read about neutralisation reaction and balancing of reaction. In this chapter, we will learn more about how various reactions take place between two or more substances and what is meant by balancing a reaction.

**Balancing a Reaction**

1) When hydrochloric acid and sodium hydroxide react, water and a salt, sodium chloride, is formed. This reaction can be shown in words and symbols as given below.

Hydrochloric acid + Sodium hydroxide = Sodium chloride + Water

$$HCl + NaOH = NaCl + H_2O$$

In this reaction, chlorine atom from hydrochloric acid combines with the sodium atom from sodium hydroxide and we get one sodium chloride molecule as a product of the reaction. During the same reaction the remaining hydrogen atom from hydrochloric acid and remaining oxygen and hydrogen atoms combine to form a water molecule. This is how we get sodium chloride and water as end products in this reaction.

2) When sulphuric acid and sodium hydroxide react, water and a salt called sodium sulphate is formed. This reaction can be shown in words and symbols as given below.

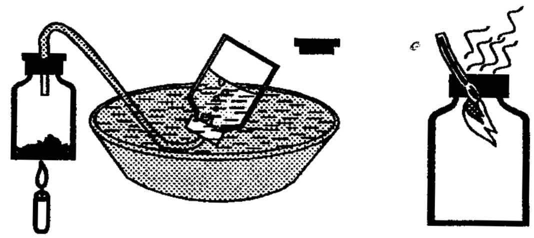
Sulphuric acid + Sodium hydroxide = Sodium sulphate + Water

$$H_2SO_4 + 2\,NaOH = Na_2SO_4 + 2\,H_2O$$

In this reaction, sodium molecules from the two molecules of sodium hydroxide combine with one sulphate molecule to form one molecule of sodium sulphate. In a similar way, two hydrogen atoms separated from sulphuric acid combine with the two hydrogen and oxygen atoms from sodium hydroxide to form two molecules of water.

We will now learn how to make oxygen gas.

**Experiment 1: To Prepare Oxygen Gas**



### Things you Need

### For Each Group

Small and big injection vials with lid, empty refills, valve tube, tub, water, candle, matchbox, essence stick, potassium permanganate, magnesium strip, sulphur powder, aluminum metal pieces, hydrochloric acid, marble pieces (calcium carbonate), litmus paper

### Note for the Teacher

Take care while handling the chemicals and candles so no one is hurt. Leave the windows open while doing the experiments. Fill the bottles with water and hold them upside down in the water filled tub to collect the gas. Do not play with the chemicals or taste them.

### New Words

Oxide
Hydroxide
Reaction
Reactants
Products Decomposition
Exothermic, Endothermic

Use one large empty injection vial with cork, empty refill and valve tube to make the arrangement of the apparatus as shown above in the picture. Leave the open end of the valve tube in a tub filled with water. Fill potassium permanganate in the injection vial and fix the cork in place. Heat this vial on the flame of a candle. What do you see coming out of the open end of the tube in the water?

---

Now fill another small injection vial with water and invert it in to the water-filled tub. Insert the open end of the valve tube in the small injection vial as shown in the picture. Allow the gas to be filled in the vial. As soon as the vial is filled with the gas, close the lid immediately. Now fill another 7- 8 vials with the gas in a similar way. ( Note: Keep aside 3 to 4 gas filled vials for using in the further experiments.)

Perform further tests to find out what was the gas that we collected in the vials. Note your observations in Table 1.

**Table 1**

| Number | Test | Observation | Conclusion |
|---|---|---|---|
| 1 | Colour | | |
| 2 | Odour | | |
| 3 | Effect on red litmus | | |
| 4 | Effect on blue litmus | | |
| 5 | Effect on burning candle | | |

We can say on the basis of the above observations and conclusions that the gas collected is oxygen. Here we saw that oxygen gas is separated from potassium permanganate. A substance is decomposed on heating to form another substance in this reaction.

When a substance forms another substance by way of decomposition, such reactions are called **decomposition reactions**.

Is the gas prepared quickly or slowly in this reaction?

---

Will you call this reaction a slow reaction or fast reaction?

---

The equation for the this reaction is written as follows:

$$KMnO_4 \xrightarrow{\text{On heating}} KMnO_2 + O_2$$

**Potassium permanganate** **Potassium manganate** **Oxygen**

**Oxides and Hydroxides of Metals**

Zinc oxide: Zn O

Magnesium oxide: Mg O

Copper oxide: Cu O

Sodium hydroxide: Na OH

Potassium hydroxide: K OH

Ammonium hydroxide: $NH_4OH$

Calcium hydroxide: $Ca(OH)_2$)

Oxides of Non metals

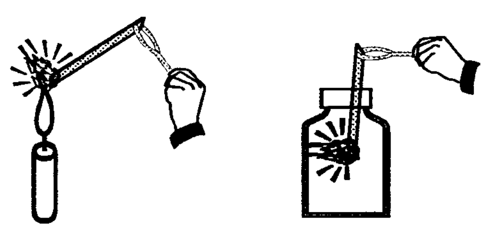
Sulphur monoxide: SO
Carbon monoxide: CO
Sulphur dioxide: $SO_2$
Carbon dioxide: $Co_2$

In an earlier lesson we learnt about atoms and molecules. We learnt that many things around us are made up of elements. Every element is different from the other as the atoms from each element have different properties. In spite of this many properties in some elements are similar.

**The elements are distributed in two groups according to common similar properties: Metals and non metals.**

We have learnt that when two atoms of two different elements come close there is an exchange of electrons taking place between them forming a compound. This compound has completely different properties than the two combining elements. So the formation of a compound is a type of a chemical reaction. When elements are heated in presence of air, then they react with the oxygen from air and form a new compound, which is known as the oxide of that element. Now we will see one more chemical reaction in the next experiment.

**Experiment 2: Making Oxides - 1**
Take the magnesium metal strip given in the kit. Hold it with pair of tongs and heat it in presence of oxygen from the air. You can also burn the magnesium strip in the oxygen vial from the first experiment. Note down your observations.



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---

What is left behind after the strip was completely burnt? Collect that on a paper. (We will need this remains for the experiment 4)

What will we call the new substance formed in this reaction?

---

The balanced equation for this reaction can be written as follows:

$$2\,Mg + O_2 = 2\,MgO$$

Magnesium + Oxygen = Magnesium oxide

In sulphur monoxide, sulphur atom is more reactive. It reacts with one more oxygen atom to form sulphur dioxide.

$$2\,SO + O_2 = 2\,SO_2$$

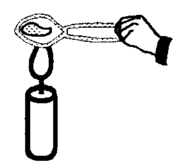
If this reaction is performed at a higher temperature, then sulphur atom combines with 3 oxygen atoms forming sulphur trioxide.

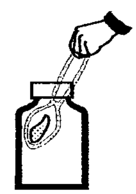
$$2\,S + 3\,O_2 = 2\,SO_3$$

In this experiment we prepared oxide of a metal element. We will make an oxide from non metal element in the next experiment.

**Experiment 3: Making Oxides - 2**

Take some sulphur powder in steel spoon and try to light it. When the powder starts burning carefully put it in a glass jar with a wide mouth. You can also put the burning powder in the oxygen vial you made in the first experiment. When sulphur is burnt completely close the bottle with a lid. Observe the process carefully.





Can you see a new substance being formed?

---

Here the new substance is in a gaseous state. (Preserve the jar with gas for Experiment 5.)

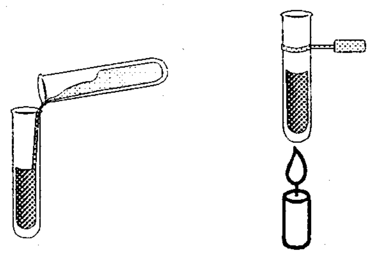
When one atom of sulphur combines with one oxygen atom the chemical equation can be written as follows:

$$2\,S + O_2 = 2\,SO$$

Sulphur + Oxygen = Sulphur monoxide

Sulphur atom is more reactive in the sulphur monoxide form so it combines with one more oxygen atom to form sulphur dioxide. In the above experiments we had elements reacting with oxygen. In all the reactions heat plays an important role. If heat is supplied to the elements then they react with oxygen faster to make oxides, which is a compound of that element with oxygen. In the next experiment we will see oxides reacting with water.

## Experiment 4: Making Hydroxides -1



The reaction of metals turning into oxides occurs naturally. Because of this, reaction vessels made from metal react with the oxygen in air and form oxides. This makes the vessels dull. The oxides of metals hold basic properties.

We apply sour substances to these vessels to clean them. Sour substances have acidic properties. Here a neutralisation reaction takes place between acidic and basic substances. This is how the layer of oxide on the vessel is removed bringing back its shine.

We often perform such chemical reactions in our day to day life.

Now we will see how oxides of non metals react with water.

Take the white ash of magnesium you collected in Experiment 2 in a test tube. Add some water to it and shake it well. You can heat the mixture on a flame of a candle. This helps magnesium oxide react with water. The chemical equation for this reaction can be written as follows:

$$MgO + H_2O = Mg(OH)_2$$

Magnesium oxide + Water = Magnesium hydroxide

Perform a litmus test on the magnesium hydroxide solution. Is this solution acidic or basic?

______________________________

You must have understood that when oxides of metals react with water hydroxides or base is formed. The reaction of metals turning into oxides is a natural phenomenon. Because of this, vessels made from metals react with the oxygen in the air and form oxides. This process makes the vessels dull. What do we do to bring back the shine of these metal vessels?

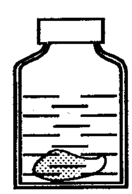
______________________________

______________________________

The reason behind this is that the oxides of metals have basic properties.

**Experiment 5: Making Hydroxides - 2**

Open the bottle from Experiment 3 and add water to it immediately. Again close the lid and shake the bottle well. This will help sulphur dioxide dissolve in water -- meaning react with water.



The equation of the reaction between sulphur dioxide and water can be written as follows:

$$SO_2 + H_2O = H_2SO_3$$

Sulphur dioxide + Water = Sulphurous acid

Do the litmus test of the sulphurous acid solution. Is this solution acidic or basic in nature?

---

If instead of Sulphur dioxide, Sulphur trioxide is dissolved in water then the reaction that occurs is as follows:

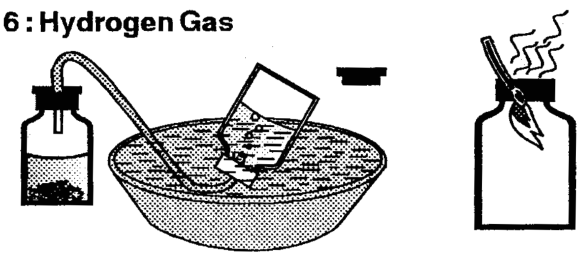
$$SO_3 + H_2O = H_2SO_4$$

Sulphuric trioxide + Water = Sulphuric acid

You must have understood that when oxides of non metals react with water, acids are formed.

In the above experiments we saw acids and bases formed at the end of the reaction. We will now see reactions acids with metal elements.

**Experiment 6 : Hydrogen Gas**



Use one large empty injection vial with cork, empty refill and valve tube to make the arrangement of the apparatus as shown in the picture. Leave the open end of the valve tube in a tub filled with water. Now fill pieces of aluminum metal and hydrochloric acid in the injection vial and fix the cork in place. After some time what do you see coming out of the open end of tube in the water?

---

Now fill another small injection vial with water and invert it in to the water-filled tub. Insert the open end of the valve tube in the small injection vial as shown in the picture. Allow the gas to be filled in the vial. As soon as the vial is filled with the gas, close the lid immediately. Now fill another 7 to 8 vials with the gas in similar way. Do the given tests to find out which gas you have prepared? Note your observations in Table 2.

**Table 2**

| Number | Test | Observation | Conclusion |
|---|---|---|---|
| 1 | Colour | | |
| 2 | Odour | | |
| 3 | Effect on red litmus | | |
| 4 | Effect on blue litmus | | |
| 5 | Effect on burning candle while holding near gas filled vial | | |

We can say from the above observations that the gas prepared is **hydrogen**. Here we saw that when a reaction takes place between an acid and **any** metal, hydrogen gas is released and the salt of the metal is produced. Is this reaction fast or does it take place slowly?

---

So what would we call this reaction? A fast reaction or slow reaction?

---

When two or more chemical substances react then either heat is released in the reaction or heat has to be supplied for the reaction to take place.

The reaction in which heat is released is called exothermic reaction.

The reaction in which heat has to be supplied is called endothermic reaction.

The substances taking part in the reaction are called reactants. The substances being produced at the end of the reaction are called products. The properties of the products are different than the properties of the reactants.

The atoms forming reactants form the products in the reaction. Therefore the number of atoms in the reactants remain constant in the products. While writing the chemical equation of the reaction the atoms on the reactant side and product side are equal and hence the equation is called balanced.

We can write the balanced equation for the above reaction as follows:

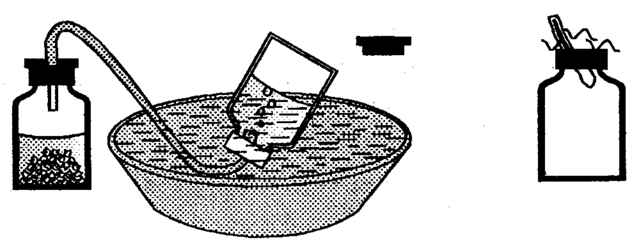
$$2Al \quad + \quad 6\,HCl \quad = \quad Al_2Cl_3 \quad + \quad H_2$$

Aluminum metal + Hydrochloric acid =
Aluminum chloride + Hydrogen gas
salt

In the next experiment we will see the reaction of an acid with carbonate salt of metals.

**Experiment 7: Carbon dioxide Gas**

Use one large empty injection vial with cork, empty refill and valve tube to make the arrangement of the apparatus as shown in the picture. Leave the open end of the valve tube in a tub filled with water. Fill powdered marble pieces and hydrochloric acid in the injection vial and fix the cork in place. Heat this vial on the flame of a candle. What do you see coming out of the open end of tube in the water?



Fill another small injection vial with water and invert it in the water-filled tub. Insert the open end of the valve tube in the small injection vial as shown in the picture. Allow the gas to be filled in the vial. As soon as the vial is filled with the gas, close the lid immediately. Fill another 7 to 8 vials with the gas in a similar way.

---

Do the given tests to find out which gas have you prepared. Note observations in the table below.

**Table 3**

| Number | Test | Observation | Conclusion |
|---|---|---|---|
| 1 | Colour | | |
| 2 | Odour | | |
| 3 | Effect on the red litmus | | |
| 4 | Effect on the blue litmus | | |
| 5 | Effect on the burning candle while holding near gas filled vial | | |

From the observations we can say that the gas is carbon dioxide. Here we saw that when a carbonate salt of a metal reacts with acid, carbon dioxide gas is released in the reaction. Chloride salt of the metal and water is also formed in the reaction. Is the gas formed instantly or slowly in this reaction? What will we describe this reaction as? Slow reaction or fast reaction?

____________________________________________

What will be the effect on the rate of reaction if we take big pieces of marble in place of powder?

____________________________________________

____________________________________________

If big pieces of marble are used in the reaction, less of calcium carbonate atoms come in contact with acid. While if powdered calcium carbonate is used large number of atoms come in contact with acid and reaction happens faster.

The balanced equation for this reaction can be written as follows:

$$CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$$

Calcium carbonate + Hydrochloric acid = Calcium chloride + Carbon dioxide + Water

### Some Common Reactions

Metals + Oxygen = Metal oxide

Water + Metal oxide = Metal hydroxide

Acid + Metal hydroxide = Metal salt + Water

Acid + Metal = Metal salt = Hydrogen

Acid + Metal carbonate = Metal salt + Carbon dioxide + Water

# 9 Measuring Volume

**Things you need**

**For Each Class**

Vessels of different shapes and sizes, sticking gum, reel of string, scissors, kerosene.

**For Every Team**

Tumblers of glass or stainless steel, sand, rubble (kapchi), test tubes, , measuring jar, graduated beaker, plain beakers, transfer vessel, cubes of 1 cu.cm that will sink in water, paper, iron pieces of different volumes.

**Note for the Teacher**

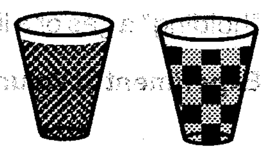
In Experiment 2, fill different vessels with about the same quantity of water.

**New Words**

Volume
Cube
Levels
Graduated beaker
Measuring jar (or cylinder)
Capacity

In Class 5 and Class 6, we had studied distance, area and mass. In this chapter we will study volumes.

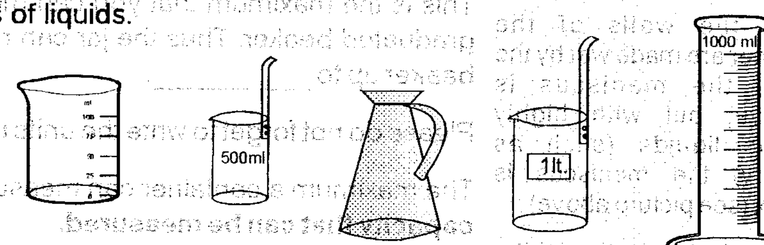
**Experiment 1: What Holds More?**



Take two similar containers of similar shape and size. Fill one with small pebbles (or small sized stones) and the other with sand. To fill the containers, did you need more number of pebbles or more number of sand particles? Why?

The pebble is bigger in shape and size than the sand particle, therefore you needed more of sand particles. A sand particle occupies less space than a pebble.

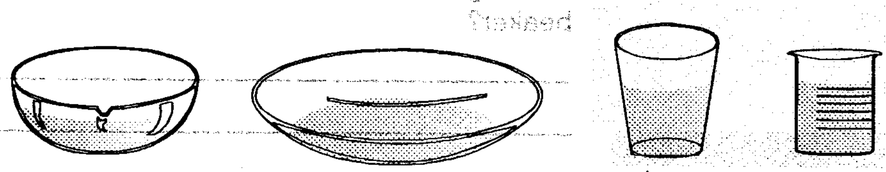
**The amount of space occupied by a substance is called its volume.**
In practice, we measure volumes of substances like milk, kerosene and other liquids. See the pictures below. These things are used to measure volumes of liquids.




What is written on each of these measuring devices?

Liter, milliliter (or cc, cubic centimeter), etc are units of volume.

**Experiment 2: Capacity - Filling Up Space**



# Measuring Volume

Your teacher will give you different containers filled with water. Observe them. Guess in which container is there more water? Why?

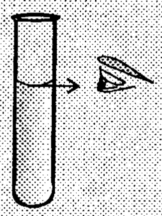
______________________________________________

______________________________________________

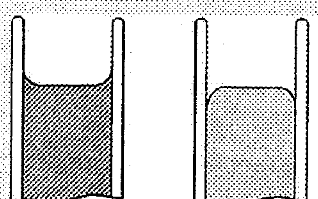
Measure the water in each of the containers with one and same measuring device. (You could use even one of the other containers.) Did your guess turn out right?

______________________________________________

**Meniscus**



Take a small test tube. Clean it and fill it up to half with water. Look at the shape of the water surface. It is a bit curved and rises up on the sides as it touches the glass. This curved surface is called meniscus.



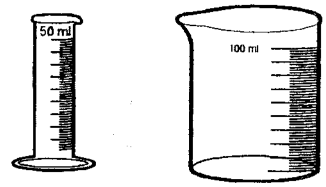
Water    Mercury

When the walls of the container are made wet by the liquid, the meniscus is concave, but with highly viscous liquids (such as mercury) the meniscus is convex (see picture above).

Your eye should be at the same horizontal level as the bottom of the meniscus of the water whenever you take readings of water levels. For mercury you will take the level at the top of the meniscus.

You know that a gas or a liquid takes the shape of its container. A bigger vessel can hold more of the liquid (or gas). The container's property of "holding" a gas or a liquid is called its **capacity.**

**Experiment 3: Volume Measurement Devices**




Take the graduated (that is the ones with markings) beaker and measuring jar from your kit. What is written next to the topmost marking? Liter or milliliter (ml)? Or cc?

______________________________________________

What is the number of ml or liters written next to the topmost marking?

______________________________________________

This is the maximum that you can measure with the measuring jar or the graduated beaker. Thus the jar can measure up to ___________ and the beaker up to __________.

Please do not forget to write the units in the above sentence.

The maximum a container can measure is called the container's **maximum capacity that can be measured.**

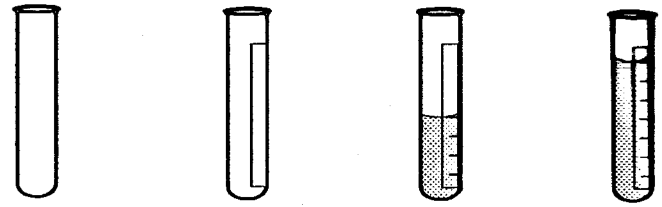
So what is the maximum capacity that can be measured for the jar and the beaker?

In Class 5, you will remember that we talked about the least count of a scale or ruler. The least count is the distance between two adjacent small markings. What is the least count of the measuring jar and the graduated beaker?

______________________________________________

______________________________________________

**Experiment 4: Make a Graduated Test tube**



Take the big-sized glass test tube from your kit. Take an 1 cm wide and 8-10 cm long strip of paper (preferably white) and stick it on the test tube as shown in the picture above. Using the measuring jar, measure 5 ml of water and pour it in your test tube. Note the water level and mark there 5 ml on a strip of paper. Similarly measure 5 ml again repeatedly and pour it in your test tube, making a mark 10, 15, 20 ml along the way. What is the maximum you can measure with the graduated test tube you have just made?

---

What is the smallest you volume that you can measure with the graduated test tube made by you?

---

Let us now use your graduated test tube as well as the graduated beaker, measuring jar, etc. and find out the capacity of containers of various sizes around you. For example, what is the capacity (or volume) of the tea cup, *katori (vatki)*, tumbler, etc. You would need to fill each with water and measure the water contained in each.

Capacity of Tea cup: ______________________

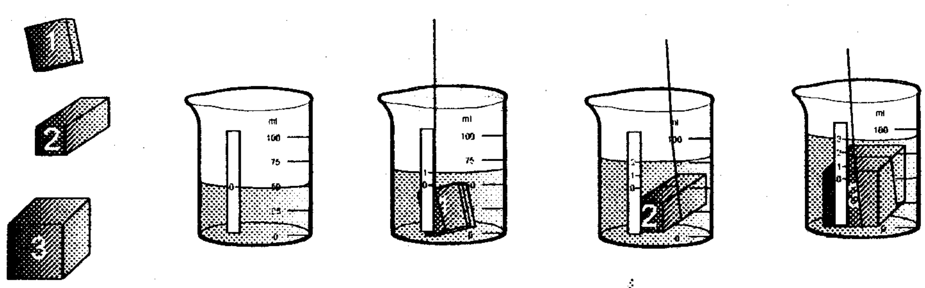
Capacity of Vessel: ______________________

Capacity of Sauce Pan: ______________________

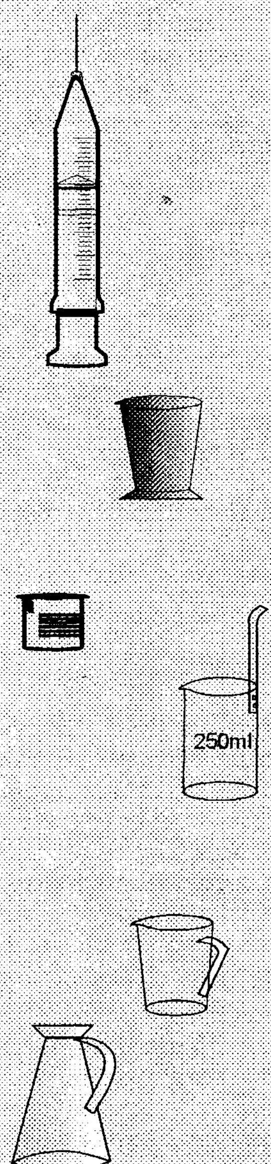
Please remember to write the units of volume every time you make your measurements.

Till now we discussed how to measure volumes of liquids. But how do we measure the volume of a solid? You have heard the story of the crow that had to drink water from a long vessel with a narrow mouth with the water well below the easy reach of the crow. We will use the same idea.

**Experiment 5: Which Solid Object has More Volume -1?**




**Some Commonly seen Things used to Measure Volume**



## Measuring Volume

### Clever Crow

This story is about a clever crow. He was thirsty. He saw a jar with lot of water but it had a narrow neck and he could not reach the water level with his beak. So what did he do? He picked up small pebbles and started dropping it in the jar. Surely after some time, the water level goes up - enough for the crow to drink.

### Which has more Water?

Consider two cans, the first containing one liter of milk and the second containing one liter of water. Suppose you take one cup of milk out of the first can and pour it into the second can. After mixing you take one cup of the mixture from the second can and pour it back into the first can. Which one of the following statements is true?

a) There is now more water in the first can than milk in the second can.

b) There is now less water in the first can than milk in the second can.

c) There is now as much water in the first can as there is milk in the second can.

Take objects of different sizes given in your kit that will sink in water. You may like to mark them 1, 2, 3, etc., for easy identification. Now take a beaker and stick a paper scale on it as before. Fill the beaker with water to about half. Mark the zero of your scale at the level where the beaker is half filled. Mark also 1, 2, 3 after the zero as before. Drop object no 1 in the beaker. Is there a difference in the water level? What was the new water level?

_______________________________________________

Mark 1 against the new level. Do the same experiment with objects 2, 3, etc. and mark 2, 3, against the new changed water levels. Which object results in the greatest increase in water level?

_______________________________________________

You have understood the reason for the increase in water level. The object requires to occupy space inside the water. Therefore the water is displaced upwards and the water level increases. Can we use this experiment to measure the volume of a solid object that sinks?

_______________________________________________

Before proceeding further, we will try and understand couple of more things about the unit of volume. As you know the meter (or cm/mm) is a unit of length. For area, since we have length and breadth, the unit of area is meter x meter, or, meter squared, or square meter written as sq.m (or sq.cm, that is cm x cm, in case we use centimeters). Volume involves length, breadth and height: therefore the unit of volume would be

_______________________________________________

Given in your kit are several objects with regular shapes. Measure their length, breadth and height

Length:__________cm Breadth:__________ cm Height:__________cm

The unit of volume is written as meter x meter x meter, or meter cubed, or cubic metre written as cu.m (or cc, cubic centimeter, in the case of cm x cm x cm.). What will be the volume of a 1 cm x 1 cm x 1 cm object? __________cc.

We will now find out the volumes of objects 1, 2, 3, etc. with the help of a cube of volume one cubic centimeter or 1 cc.

Again, take the beaker. Fill it with water up to the zero mark you have created. Now drop in the water plastic cubes of volume, 1 cubic cm, that is, 1 cc. When the water level goes up to the level marked 1, stop dropping the cubes.

How many cubes did you need to drop for the water to go up from the level marked 0 to 1?

_______________________________________________

So then, what is the volume of object no 1?

Try and find the volumes of objects no 2, 3, etc., in a similar fashion. How many 1 cc cubes did you need for the water level to go up to the level marked 2?

What therefore is the volume of object 2?

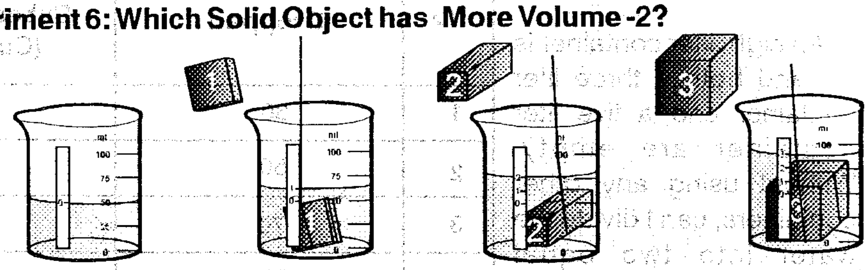
For level marked 3, how many cubes did you need?

So what therefore is the volume of object 3?

Would you say that the solid objects that displaces least amount of water has the least amount of volume?

You have seen in the above experiments that any solid object when immersed in water displaces an amount of water whose volume is equal to the object's volume. Will this hold if we used any other liquid like kerosene, milk, ground nut oil, etc.? Let us do another experiment to confirm our guess.

**Experiment 6: Which Solid Object has More Volume -2?**



Take the beaker of Experiment 5. Fill kerosene up to the level marked zero. Now sink Tie a thread around object 1 and sink it in the kerosene in the beaker. What was the new level of kerosene in the beaker?

Did the level of kerosene reach till the level marked 1?

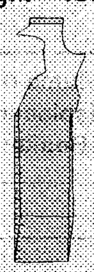
No take the object out of the beaker. What happens to the level of kerosene in the beaker?

**Units of Volumes**

Normally the volume of any liquid is described in units of milliliter (ml), cubic centimeter (cc) or liter; whereas volumes of solid objects and gases are mentioned in cubic centimeter (written as cu.cm and not cc) and cubic meter (cu.m). This is just a convention.

**What is the Volume of the Bottle?**

1) A square bottomed bottle which is flat is partly filled with liquid. Can you find the volume of the liquid in the bottle using only a ruler? (Remember: volume = length x breadth x height, that is, area x height = volume.)



2) Suppose you have two bottles with equal circumference, thickness and height. One bottle is cylindrically shaped; the other one has the shape of a rectangular box with a square shaped bottom. In which of the bottles can I pack more milk? ("Circumference" of a square is the same as its perimeter.)

3) How can I have a bottle of zero volume?

Now do the same exercise with objects 2 and 3 too. Does the kerosene go up by the same amount as did the water?

From Experiments 5 ad 6, what can you conclude?

1) To displace one liter of water, how much volume of a solid would need to be immersed in the water?

2) I have a 3 liter jar and a 5 liter jar and 100 liters of water in a third jar. How do I measure exactly one liter of water assuming I can pour back and forth any number of times? No other volume measuring device is available.

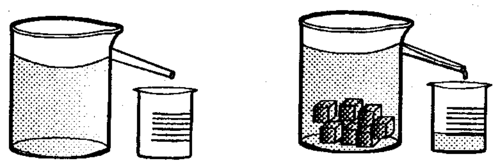
3) Can I measure one liter with a 5 liter and 7 liter jars? How about with a 6 liter and 8 liter jars can I measure one liter?

4) An eight liter container is full and both a three liter container and a five liter container are empty. Without using any other containers, can I divide the water into two equal amounts?

Let us now learn one more method of measuring volume?

**Experiment 7: One More Method of Finding Volume**

Take the displacement vessel from your kit. Place it on a level surface. Fill it up with water to the brim. Keep a graduated beaker under its mouth to collect the excess water. When water stops dripping out of the spout (outlet) of the transfer vessel, empty the beaker and place it again under the spout of the transfer vessel. (see picture)



Now start dropping, slowly, in the transfer vessel, the one cm plastic cubes. Count the number of cubes as your drop them in the water. Note your observations in the table below.

**Table 1**

| Sr No | No of Cubes Dropped | Total Volume of Cubes Dropped (Cubic cm) | Volume of Water Displaced in the Beaker (ml) |
|---|---|---|---|
| 1 | 30 | 30 | |
| 2 | 50 | | |
| 3 | 70 | | |
| 4 | 90 | | |

What is the volume of 30 cubes?

What was the volume of the water displaced by the 30 cubes?

What is the relationship between the volume of the cubes you dropped in the water and the volume of the water displaced?

______________________________________________

How much water does a 1 cm cube displace?

______________________________________________

Often the unit of volume of a liquid is written in ml instead of cu.cm or cc. Can you therefore write 10 ml of water as 10 cc or 10 cu.cm of water?

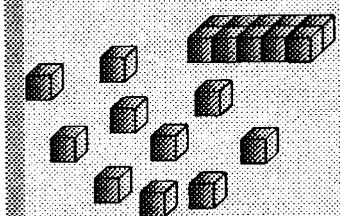
______________________________________________

______________________________________________

______________________________________________

______________________________________________

Different shaped objects may have equal volumes. Let us see how.

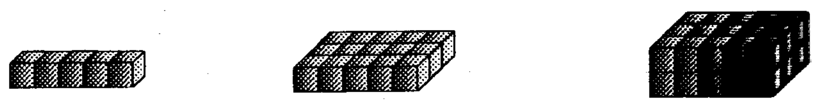


A total of 20 cubes are given to you, and each of them has volume 1 cu.cm. Using all of them, make all the shapes shown in the next page.

Have a look at the area covered on the plain surface below by these objects? Do they all cover equal areas?

Would you say their volumes or equal or different? Why?

**Experiment 8: Formula for Volume**



**Shape 1** **Shape 2** **Shape 3**

As shown in the picture above, make several regular shapes by **joining** the 1 cu.cm cubes.

Write how many cubes you have used in each?

Number of cubes used for shape 1? ______________

What therefore is the volume of shape 1? ______________

Number of cubes used for shape 2? ______________

What therefore is the volume of shape 21? ______________

Number of cubes used for shape 3? ______________

What therefore is the volume of shape 3? ______________

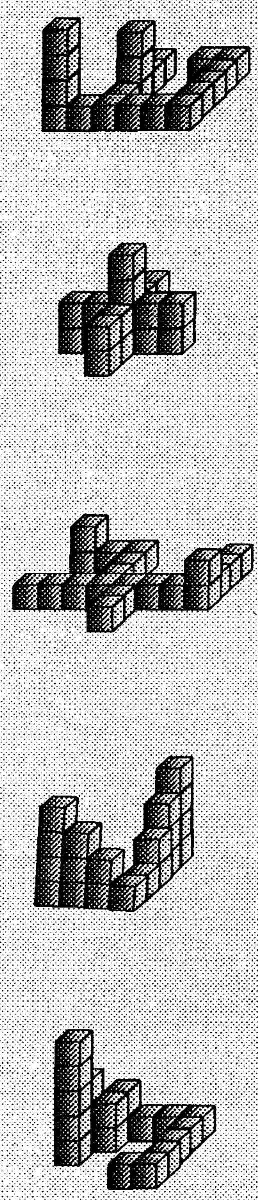
**Table 2**

| Shape No | Volume in cu.cm | Length (l) of shape cm | Breadth (b) of shape cm | Height (h) of shape cm | Volume l x b x h (cu.cm) |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

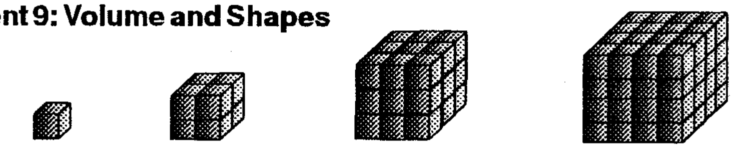
## Measuring Volume

You probably have now concluded that the volume of any cubical shaped body involves its length, breadth and height. This is true by and large: volume of any body involves measuring along three dimensions.

You have also learnt in the chapter on area in Class 6 that if you double the side of a square, its area goes up 4 times. If you halve the side, it decreases by a fourth. Let us see what happens to the volume of a cube if you do similar things.



**Experiment 9: Volume and Shapes**



A B C D

Take the cube of one cu.cm. Let us call it A. Fill details of A in the Table 3 below. Now using cubes of one cu.cm make another cube, let us call it B, with side twice the length of that of A, that is its length, breadth and height of 2 cm. Fill details of B also in the Table below. Similarly make objects C and D such that the sides are 3 cm and 4 cm. Fill details in Table 3 below as before.

**Table 3**

| Name of the Cube | Length of a side of the cube (cm) | Volume (cu.cm) | How many times more than the volume of A |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

If you double the side of a cube, by how much does its volume increase?

_______________________________________________

If you need to increase the volume of a cube 27 times, how many times should the side be increased?

_______________________________________________

If you need to reduce the volume of a cube by eight, how would each side change?

_______________________________________________

If you reduce the side to $1/3^{rd}$ of its length, by how much would the volume decrease?

_______________________________________________

# 10 Density

**Things Required**

**For Each Class**

Balance, weights

**For Each Team**

Injection bottles, test tubes kerosene, water, sand, oil, different articles (objects), iron cube, plastic cube beaker, displacement vessel, hollow glass tube, rubber cork for teachers.

**Note for the Teacher**

Substances (liquid) like kerosene, oil to be brought by students from home. They need to be told in advance.

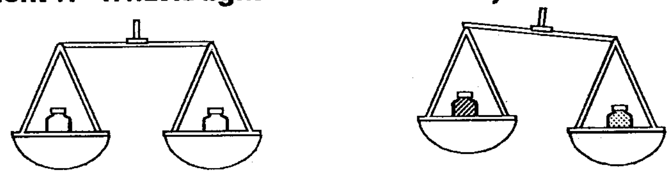
**New Words**

Density, Archimedes' Principle

What would weigh more: 5 grams of water or 5 grams of kerosene ?

What would occupy more space: 5 grams of water or 5 grams of kerosene ? What would have more mass, 5 cc of water or 5 cc of kerosene ? (One cc = One ml)

**Experiment 1: What is light and what is heavy ?**



Take a balance (scale) given in your kit. Take two 5 ml injection bottles having same mass and measure individually their mass by scales.

Now put each one of them in two different pans of the scale and see whether they are balanced ?

________________________________________

Now fill 5 ml of water in one of the bottles with the help of a measuring cylinder. Similarly fill 5 ml of kerosene in the other bottle. Put the bottle filled with water in one of the pans and the one filled with kerosene in the other pan. Now observe whether both the pans are balanced? Which one of them goes down ?

________________________________________

Thus, though we took the same volume of water and kerosene their masses are not the same. The mass of a body is said to me more when the pan containing it moves down (towards the ground) as compared to the other. Now can you say what was has more mass - water or kerosene ?

________________________________________

What is heavier: water or kerosene ?

________________________________________

In the language of science the substance which has more mass (that is matter) for the same volume is said to have greater density.

# Density

### Density and Temperature

A factor that affects the density of a material is temperature. Many materials expand when they are heated. Because a material that expands will take up a larger volume, its density will decrease. You see this commonly with gases and some liquids and explains how hot air balloons work. When the air inside of a balloon is heated it expands and its density decreases. The balloon thus gains positive buoyancy (or upthrust - see next chapter) with respect to the colder air surrounding it and it floats into the sky.

### Pressure has the Opposite Effect on Air Density

Increasing the pressure increases the density. Think of what happens when you press down the handle of a bicycle pump. The air is compressed. The density increases as pressure increases.

As you go higher, the pressure of air decreases. At 100,000 feet above sea level the air's pressure is only about a hundredth of what it is at sea-level.

If you go high enough you will begin feeling the effects of lower air pressure and density.

As air pressure decreases oxygen continues to account for about 21% of the gases in the air as it does at sea level. But, there is less oxygen because there is less of all of the air's gases. By the time you go to 12,000 feet the air's pressure is about 40% lower than at sea level. This means that with each breath you are getting about 40% less oxygen than at the lower altitude.

Here after, instead of saying water is "heavier" than kerosene, we shall say that the density of water is more than the density of kerosene, i.e., water is denser than kerosene. Now let us find the density of water. Note the mass of the bottle filled with water when kept on the left balance of the scale.

________________________________________

Throw out the water and find the mass of the empty bottle. Subtract the mass of the empty bottle from the previous reading of mass of bottle water: what does this weight indicate?

________________________________________

Now divide this mass of water with its volume. This ratio is the density of water.

$$\textbf{Density} = \frac{\textbf{Mass}}{\textbf{Volume}}$$

The unit of density is found thus:

$$\textbf{Unit of density} = \frac{\textbf{Unit of mass}}{\textbf{Unit of volume}} \qquad \textbf{E.g. Grams/cubic cm}$$

What is the density of water?

________________________________________

Similarly find the density of 5 ml kerosene.

________________________________________

Is the density of kerosene more or less than that of water?

________________________________________

This is how we find the density of liquids. Now let us find the density of a solid object.

**Experiment 2: Different Masses with Same Volume**

Take two cubes of the same volume given in the kit. You would have studied how to measure volume of a cube. Note volumes of **both the cubes** using the formula. Is the volume of both cubes same? **Now measure their** masses of different substances having same volume. **Now find the** density of these cubes by using the above formula.

________________________________________

________________________________________

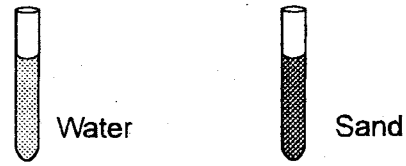
Which cube has more density?

________________________________________

This is how a solid substance is compared with another solid **substance.**

Now let us compare the density of a solid and a liquid.

**Experiment 3: Comparison of a Solid and a Liquid**




Take two similar test tubes. Fill one with water and the other with sand to the same height (why?). Take them in your hand. Observe their weight which one is heavier ?

---

So the density of which substance is greater?

---

Now put a pinch of sand in the test tube filled with water. What happens ?

---

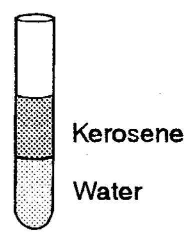
Thus, it could be inferred that sand sinks in water as it is heavier than water. From this try to predict whether kerosene poured in water will sink or float ?

---

So we can conclude that the object having more density would sink in a liquid having lesser density ? Let's do an experiment.

**Experiment 4: What would float and what would sink ?**

| Substance | Density in (gm/cc) |
|---|---|
| Air | 0.0013 |
| Wood(oak) | 0.85 |
| Water | 1.00 |
| Ice | 0.93 |
| Aluminum | 2.7 |
| Lead | 11.3 |
| Gold | 19.3 |
| Ethanol | 0.94 |
| Methanol | 0.79 |



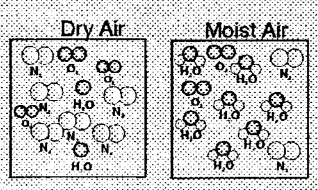

Take a long test tube. Fill its quarter part with water . Now add about 15-20 ml of kerosene in it. Shake the test tube properly. Observe after some time. Which liquid is on the top ?

---

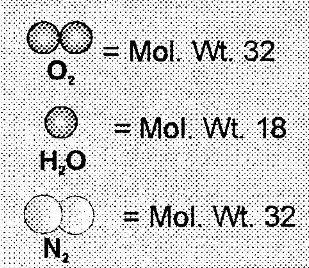
We could say that liquid having more density remains at the bottom of the test tube compared to that having less density (which remains on the top). This experimental observation is one more example of the above derived principle.

**Moist Air is Less Dense**

Most of the air is made up of nitrogen molecules $N_2$ with a somewhat lesser amount of oxygen $O_2$ molecules, and then other molecules such as water vapor.




**Molecular weights of different molecules**




Therefore, when a given volume of air, which contains only a certain number of molecules, has some water molecules in it (which are very light weight), it will weigh less than the same volume of air without any water molecules.(dry air)

## Density

### Eureka! Eureka!

In Greece, about 2200 years ago their lived a scientist named Archimedes. Once the King of Greece, asked his goldsmith to make a crown. The crown was nice. But the king suspected that the gold used in the crown was impure. The king asked Archimedes to find out, without breaking the crown, whether the gold used was pure.

This set Archimedes thinking. He happened to go to the bath, and on getting into a tub observed that the more his body sank into it the more water ran out over the tub. He suddenly jumped out of the tub and rushed home naked, crying repeatedly in Greek, "Eureka, eureka." meaning "I have found (it), I have found (it)."

Archimedes made two blocks of the same weight as the crown, one of gold and the other of silver. He filled a large vessel with water to the very brim, and dropped the block of silver into it.

The amount of water that overflowed was equal in volume to that of the silver block sunk in the vessel. Archimedes refilled the vessel and dropped the block of gold into the full vessel.

Not as much water overflowed because gold is more dense than silver, so the same weight takes up less volume. Finally, Archimedes filled the vessel again and dropped the crown itself into the water.

He found that more water overflowed for the crown than for the mass of gold of the same weight. He concluded that the crown was of impure gold. Can you now say how?

Now collect small solid things like wax, sand, match stick, and pins etc., and put them in the test tube one after the other. Write your observations in Table 1.

**Table1**

| Objects floating on kerosene | Objects suspended between water and kerosene | Objects sinking in water |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

How will you compare the density of objects floating on kerosene with densities of water and kerosene?

______________________________________________

______________________________________________

Now compare the density of objects floating between water and kerosene with that of water and kerosene?

______________________________________________

______________________________________________

Similarly compare the density of objects sinking in water with that of water and kerosene?

______________________________________________

______________________________________________

### Archimedes' Principle

All objects are found to weigh less when immersed in a liquid. It is easier to lift a rock in water than it is on dry land. Standing in a swimming pool, a child can lift up an adult. People who have weak bones or joints are sometimes advised to perform their exercises standing in the swimming pool so as to safeguard against damage to bones caused by high impact. This is because every liquid exerts a net upward force on all objects immersed in it. This upward force helps to support all or part of the weight of the body immersed in it. The upward force exerted by a fluid on any object placed in it is called buoyancy or hydrostatic upthrust. The upthrust is thus the weight of the displaced liquid.

Archimedes' Principle states that any body partly or wholly immersed in a liquid experiences an upthrust which is equal to the weight of the liquid displaced.

# 11 Why Things Float?

**Things you Need**

**For Each Class**

Weights, physical balance

**For Each Team**

Spring balance, tubes, solid blocks, water, sand, different things of different sizes, cubical blocks of iron, plastic blocks, beaker, transfer vessel, wide beaker of glass, rubber stopper.

**Note for the Teacher**

Ideally and scientifically, this lesson should be done with physical balances. Wherever weights are being measured with physical balances, you need to mention the unit of weight as gm-weight, kg-weight, etc.

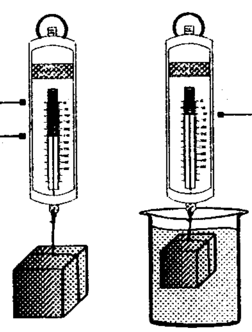
**New Words**

Density
Up thrust
Buoyancy

When you draw water from a well, the vessel filled with water feels lighter under water: when the filled vessel is taken out of the water, the vessel suddenly feels heavier. All objects appear to lose weight when immersed in a liquid. We try and understand in this chapter why this is so.

**Experiment 1: Principles of Floatation - 1**

Weigh the solid iron block in your kit with the spring balance. And weigh it again after you have immersed the iron block in a beaker full of water. Note the spring balance readings both times.




What is the difference in both the readings?

---

The block is lighter inside the water, because the water, which makes way for the solid block, pushes the solid upwards. This upward force experienced by the iron block happens to any object in any liquid. **The upward force exerted by a fluid (gas or liquid) on any object placed in it is called buoyancy or up thrust.** Every liquid exerts a net upward force on all objects immersed in it. This upward force helps to support all or part of the weight of the body immersed in it. This is the reason the iron block immersed in the water, or a filled bucket in a well, feels lighter. Outside the water, there is no up thrust on the solid due to the water.

**Experiment 2: Principles of Floatation - 2**

Again using the spring balance, note the weight of a plastic cube or wooden block. Now place the plastic cube or wooden block on the surface of a beaker filled with water. The object will float. Weigh the floating object again with the spring balance. What is the difference in the two readings of the spring balance?

---

### Submarines: How They Work - Archimedes' Principle

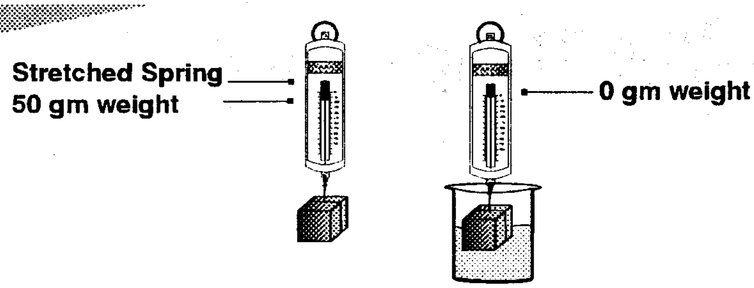
Whether a submarine is floating or submerging depends on the ship's buoyancy. Buoyancy is controlled by the ballast tanks, which are found between the submarine's inner and outer hulls.

A submarine resting on the surface has positive buoyancy, which means it is less dense than the water around it and will float. At this time, the ballast tanks are mainly full of air.

To submerge, the submarine must have negative buoyancy. Vents on top of the ballast tanks are opened. Seawater coming in through the flood ports forces air out the vents, and the submarine begins to sink.

The submarine ballast tanks now filled with seawater is denser than the surrounding water. The exact depth can be controlled by adjusting the water to air ratio in the ballast tanks. Submerged, the submarine can obtain neutral buoyancy. That means the weight of the submarine equals the amount of water it displaces. The submarine will neither rise nor sink in this state.

To make the submarine rise again, compressed air is simply blown into the tanks forcing the seawater out. The submarine gains positive buoyancy, becomes less dense than the water and rises.




When an object floats on water its weight would be zero. This is because the upward force or up thrust acting on it is equal to its downward acting weight. Remember the downward acting weight is due to the force of attraction of the earth. If the up thrust were more than the weight of the object, what would happen to the object?

From the above two experiments, we can derive the principles of floating objects (or why things float):

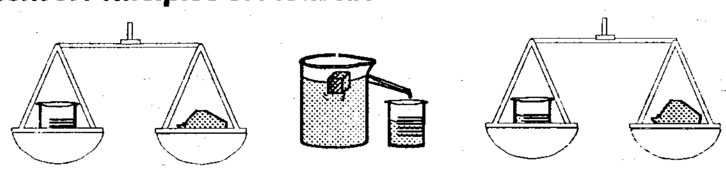
**Every liquid exerts a net upward force on all objects immersed in it. This upward force helps to support all or part of the weight of the body immersed in it and reduces the weight of the body. (Experiment 1)**

**For an object to float on a liquid the up thrust must be equal to the weight of the object. Its weight will be therefore zero when floating. (Experiment 2)**

**When any object is immersed or floats on water (or liquid), some of the water is displaced (or moves up, or spills over, to make space for the object).**

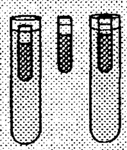
What is the relationship between the weight of the water displaced and the weight of the solid object? That is what our next experiment will explore.

**Experiment 3: Principles of Floatation - 3**



Take the graduated beaker from your kit. Using a two-pan physical balance, balance the empty beaker with some sand on the other pan. Now take the transfer vessel (the one with the protruding pout) from the kit. Keep it on a level surface. Place a graduated beaker (see picture) next to the spout of the transfer vessel. Fill the transfer vessel almost to the brim such that any slight displacement of the water surface will result in the water flowing out of the pout. When the water surface of the transfer vessel is stable, and no water is dripping out of its spout, place a plastic cube on the surface of the water. Water will get displaced through the mouth of the transfer vessel. Collect it in the empty graduated beaker.

## Why Things Float?

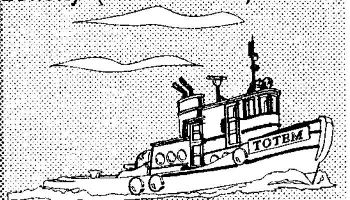


Take a small test tube. Fill a third of the test tube with sand. Fill a bigger test tube with water almost completely. Place the small test tube in the bigger one. Make a mark at the level up to which the smaller test tube sinks. Next take out the small test tube and place it in a bigger test tube filled with salt water. This time around note the level up to which the smaller tube sinks.

Did the small tube sink to a greater depth or less in salt water?

Is the density of saltwater greater or less than that of ordinary water?

Compared to its level in water, would a floating object sink, more in a liquid of higher density (than water)?




A piece of solid iron ball will sink in water. This is because the weight of the solid iron piece is greater than the weight of the water displaced by it.

But a ship made of steel (or iron) floats in water because its weight is equal to the weight of the water displaced.

Now place the beaker with the water collected in the **same pan of the** balance as before. And the plastic cube in the other pan **the one with sand** on it. Do the pans balance?

___

Does it mean that the weight of the plastic cube is equal to the weight of the water displaced by it?

___

Repeat this experiment with other objects that float on water. For instance a plastic bottle, a piece of wax, an empty steel katori, an empty injection bottle closed with rubber stopper, a piece of wood, etc. Note your readings in the table below.

**Table 1**

| Number | Name the body which float on the water | Weight of the floating body | Weight of the water displaced by the body while floating |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

In every case above, is the weight of the body equal to the weight of the water displaced by it?

___

**What special property of a floating body does the above experiment indicate?**

___

___

Let us move on to understand something about bodies that sink in liquids.

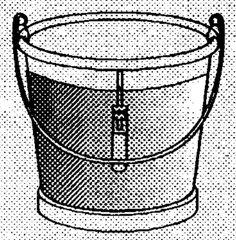
**Table 2**

| Number | Name of the body that sinks in water | Weight of the body | Weight of the water displaced by the immersed body |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

This time around is the weight of the water displaced equal to the weight of the body immersed?

Is the weight of the immersed body greater or less than the weight of the water displaced by it?

### Separating Water from Milk



The amount of water that is mixed in "pure" milk can be found by the use of a lactometer. We will make a lactometer as below.

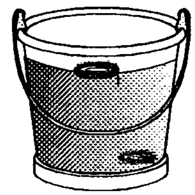
Take a big test tube. Fill it almost half with sand and close it with a rubber stopper with a hole. Pass a glass tube (piping), open on both sides, through the hole in the stopper.

Ensure that about 15 cm of the glass tube is sticking out of the test tube stopper. Place it all inside a bucket of water. Adjust the sand contents so that only 5-7 cm of the glass piping sticks out of the water. Your lactometer is ready.

You can measure the amount of water mixed in the milk it by noting how far does the tube sink in pure milk.

You may have observed that bodies, which float, also sink in some circumstances. Let us study about these.

**Experiment 5: Floating, Sinking and Shape of the Body**



Take a lid, made of some metal, say of a used soft drink bottle. Fill a bucket with water. Gently place the lid on the water surface as shown in the picture. Does the lid float?

Now change the shape of the lid by pulling it in so that it becomes almost spherical. And again place the body in the same way on the water surface. Does the lid float now?

Would the weight of the water displaced be more, or less, than the weight of the lid?

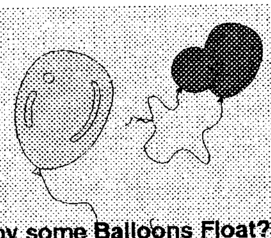
What would be the relationship between the weight of the lid while floating and the weight of the water displaced by it?

After the shape of the lid is changed, what would be the relationship between the weight of the changed shape of the lid and the weight of the water displaced by it?

Does the volume of the water and therefore the weight displaced, change with the shape of the object floating or sinking?

## Why Things Float?

**An iron nail sinks in water but a ship made of iron floats. What could be the reason?**



### Why some Balloons Float?

A body in air also experiences an upthrust by an amount equal to the weight of the air displaced. In the case of a helium filled balloon, this upthrust exceeds the weight of the balloon and its contents. This is why the balloon rises in air and needs to be tethered by means of a string which provides the necessary additional downward force to maintain equilibrium.

In the case of bodies of significantly higher densities than that of air, there is still an upward buoyant force exerted by the air displaced. A body weighed in air therefore yields a smaller reading than when weighed in vacuum. The amount by which the weight in air is inaccurate depends upon the density of the body relative to air.

### Poori Talk

Can you now say why a poori when it is fried first sinks and when it fills floats on the surface of the hot oil.?

### More Balloon Talk

Normally a balloon filled with air does not shoot up but one filled with helium gas does so. Density of helium gas is 0.00018 gm/cc whereas that of air is 0.125 gm/cc. Can you now say why?

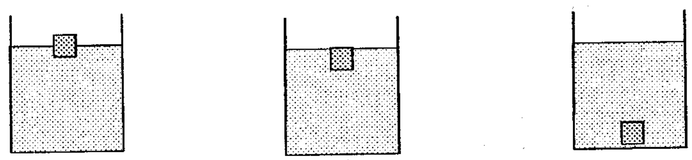
Let us recollect the various principles of floating and sinking of bodies.

$$\textbf{Density} = \frac{\textbf{Mass}}{\textbf{Volume}}$$

$$\textbf{Unit of Density} = \frac{\textbf{Unit of Mass}}{\textbf{Unit of Volume}} \qquad \textbf{Eg. Gm/cc}$$

Let density of liquid=B

Let density of solid (which is not hollow anywhere inside) = A





We have learnt the following principles of floating (some of them are in effect mean the same). They all follow from Archimedes' Principle - think how?

- When a body floats on a liquid, then its net weight is zero because the downward acting force due to the weight of the body is equal to the upward thrust of the liquid displaced.
- The weight of a floating body is equal to the weight of the liquid displaced.
- The weight of the liquid displaced by a floating object is equal to the upward thrust experienced by the body.
- When the weight of the body is greater than the upward thrust, then the body sinks in the liquid.
- The weight of the immersed body is less than its weight in air. The difference is equal to the up thrust on the body.
- When a body floats in a liquid of higher density, the volume of the heavier liquid displaced is less than what it would have displaced in a lighter liquid. This is the basis of the working of a lacto-meter.

**A question**

A block of wood easily floats on water when on the Earth. If the same block of wood were taken to the Moon, would it float on water?

# 12 Light -3

**Things you Need**

**For Every Group**

Transparent glass, water, pencil, glass slab, mirror, paper, Convex lens, concave lens, candle, match box, lens stand.

**Note for the Teacher**

Discuss the differences between the real and virtual image with children. Also discuss why we don't get the image of the object placed at the focus.

**New Words**

Refraction
Incident ray
Refracted ray
Emergent ray
Rarer medium
Denser medium
Convex lens
Concave lens
Optical center
Principal focus
Center of curvature
Principal axis
Focal length
Radius of curvature
Image
Virtual
Real

Light rays get reflected from surfaces. They are also transmitted through any transparent object or medium. That is why we are able to see through the transparent objects most times.

Make a list of transparent objects you know of:

________________________________________

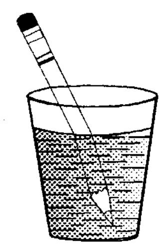
________________________________________

________________________________________

________________________________________

These transparent objects are made of solids, liquids and gases. Whenever a ray of light passes through a transparent medium, it changes its direction. Let us perform an experiment to find out how does this happen.

**Experiment 1: A "Bent" Pencil**



Take a glass. Fill it with water to three quarters. Place a pencil in it with the pencil resting one side of the glass. View this pencil near the level of the water from the side of the glass. How does the pencil look near the surface of the water?

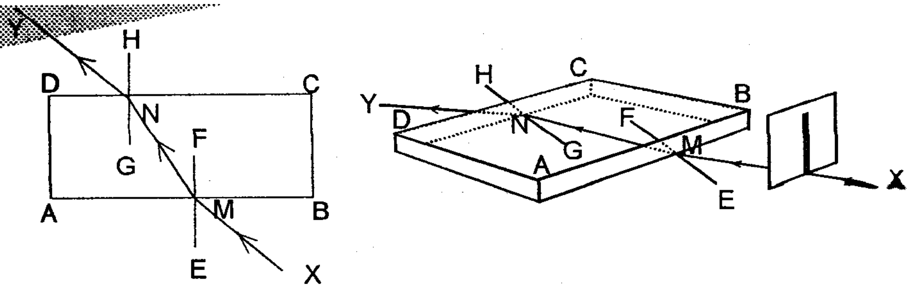
________________________________________

Light changes its direction while travelling from one medium to another in the same manner. Let us perform another experiment get the proof of this process.

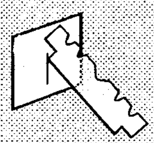
**Experiment 2: Refraction**

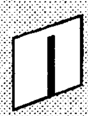
Take the glass slab given in the kit. Place it on a white paper and mark the sides of the slab with pencil. Lable the four corners as **ABCD**.

You learned to make a paper slit in Class 6. Refer to the screen and make a slit in the same way.




**How to make a slit?**





Take a cardboard and make a slit with the help of a blade as shown in the picture. Try to make the slit as thin as possible.

Arrange for a ray of light to fall on the side **AB** of the glass slab. Mark **two** points falling on this ray on the paper. Now locate the ray coming out from the side **CD** of the glass slab. Mark two points on this ray too. Now remove the glass slab from the paper. Draw ray **XM** towards the side AB as shown in picture. Draw a perpendicular passing through point M falling on side AB. Name this perpendicular as **EF**. Similarly draw perpendicular NY passing through point N falling on side **CD** of the glass slab. Now join the points M and **N**.

In which medium is the ray **XM** travelling? Air or Glass?

________________________________

In which medium is the ray **MN** travelling? Air or Glass?

________________________________

In which medium is ray NY travelling? Air or Glass?

________________________________

Is air medium denser than glass or lighter?

________________________________

Now measure the angles EMX and FMN. Write down the measures.

________________________________

Which angle is bigger?

________________________________

Now measure the angles HNY and GNM.

________________________________

Which angle is bigger?

________________________________

Answer the following questions with reference to the above observations.
In which medium is the ray of light away from the perpendicular and makes a larger angle?

________________________________

In which medium does a ray of light make a smaller angle with the perpendicular as it is nearer to it?

______________________________________________

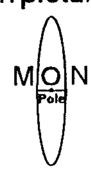
______________________________________________

**When a ray of light enters a denser medium from a rarer (less dense) medium, it bends (refracts) towards the perpendicular. When it enters the rarer medium from the denser medium, it bends away (refracts away) from the perpendicular. This behaviour of light is called refraction of light.**

You know by now why does a pencil standing in the glass of water looks bent? You have handled a simple lens earlier. How is the surface of a lens to look at?

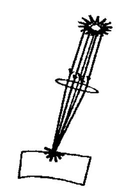
______________________________________________

The magnifying lens is called a convex lens in the language of science. Rays of light are also refracted from the convex lens. Let us perform experiments with the convex lens. Before that we need to find out some of the facts about the convex lens. Look at the given picture carefully.




If we draw a line segment MN through the center points of the both curved surfaces of a lens, the midpoint O of the line segment MN is the Pole of the lens.

**Experiment 3: Burn the Paper with a Lens!**



Stand outside in the sunlight with black coloured paper and a lens. Allow sun's rays to pass from a lens and fall on the black paper placed on the ground. What do you see on the black paper?

______________________________________________

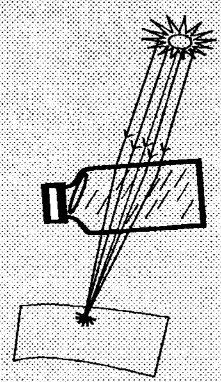
Now move the lens forward and back. You will see the rays getting concentrated on the black paper in form of a bright spot.
What is the intensity of the spot of the light? Bright or dull?

______________________________________________

Do you see the sun's rays are getting concentrated, that is focussed, at this one spot?

______________________________________________

**Burn a paper**



In Class 5, you made magnifying lens (convex lens) with an injection bottle filled with water. Now focus sun's rays on this magnifying lens with the help of slit you made. On the other side of the bottle can you see these rays meeting at a point? This is the focus of your lens made out of the injection bottle. So now can you say what is the focal length of your lens?

This bright spot of light is the focus of the lens. Now measure the



**This bright spot of light is the focus of the lens. Now measure the** distance from the lens to this bright spot. Note it down in the book.

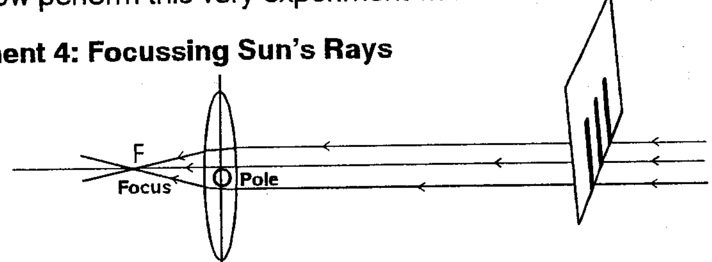
______________________________________________

**The distance from the pole of the lens to the focus of the lens is called the focal length of the lens.**
What is the focal length of your lens?

______________________________________________

Let us now perform this very experiment with a different method.

**Experiment 4: Focussing Sun's Rays**




You have learned to make a slit from a cardboard. Make three parallel slits in the cardboard as shown in the picture. Fix the convex lens on a stand you have prepared. Take this arrangement of a lens and slits in the sunlight. Allow the parallel rays of the sun through the slit to fall on the lens. Do you see the rays meeting at a particular point after coming out of the other side of the lens?

______________________________________________

What will you call this point?

______________________________________________

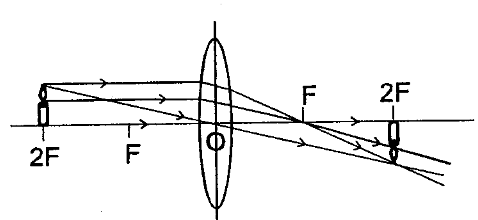
Measure the distance of the above point from the lens. What is this distance called?

______________________________________________

How far is the sun from the lens in this case?

**The image of an object at infinite distance from the lens is obtained at the focal point of the lens.**
Now we shall place an object at twice the distance of focal length and try to obtain an image.

**Experiment 5: Obtain an Image-1**




### Telescope

We all enjoy watching the stars at night. A telescope is used to observe the stars in greater detail. Two convex lenses of different focal lengths are used to make a telescope. Here, the stars are the object for viewing through the convex lens. The convex lens towards the stars is called the objective lens which has a longer focal length. The convex lens through which we observe the stars is called the eye piece which has a shorter focal length. If the parallel rays coming from the distant object fall on the convex lens, where and how will be the image be formed? This image acts as the object for the eye piece and is at a shorter distance than the focal length of the eye piece and so we get a virtual image.

# Light - 3

Fix a convex lens on a stand. Place a candle at a distance that is twice its focal length - on one side of the convex lens. What is the distance between the lens and the candle?

______________________________

**The distance between the object and the lens is called object distance.** Now try to get the image of the candle on a plane paper on the other side of the lens. How is this image? Smaller, larger or of the same size of the candle? Is this image straight or inverted?

______________________________

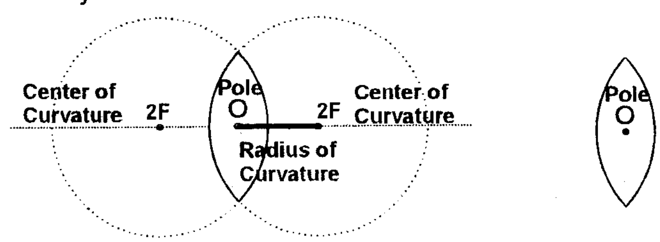
What is the distance between a convex lens and the image?

______________________________

**The distance between a lens and an image is called image distance.** In this experiment do you get image distance and object distance almost same?

______________________________

**Twice the distance of the focal length of a lens is called its center of curvature.**
You remember your curved mirrors from Class 6. Look at the given picture carefully.




If an imaginary circle is drawn, with the curved surface of a convex lens as the arc of such a circle, then the center of such a circle is called **center of curvature** of the convex lens. The distance between the pole of the lens and center of curvature is called the **radius of curvature.** This radius of curvature is double the focal length.

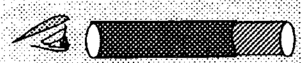
**Circle the right choice from below:**

1. At which point do we place the candle in this experiment?
   (A) Pole O
   (B) Focus F
   (C) Center of curvature (2F)

2. At which point do we get an image on the other side of the lens in this experiment?
   (A) Pole O
   (B) Focus F
   (C) Center of curvature (2F)

Now let us try to keep an object between the focus and center of curvature of a convex lens and obtain an image.

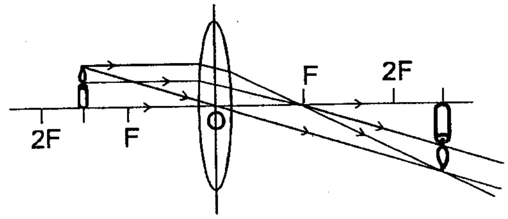
### Make a Telescope



Take two PVC pipes of different diameter so that one pipe can easily slide into another. Take two convex lenses of different focal length. Fix the convex lens with the longer focal length to the pipe with the larger diameter. This is the objective lens of your telescope which we will place towards the object. Towards one end of the pipe with smaller diameter, fix the convex lens with the shorter focal length. This is your eye piece and this will be kept near your eye. Now as shown in the picture, gently slide the smaller pipe inside the larger pipe. Now your telescope is ready!

Now observe the distant objects from your telescope. As far as possible, use objective of higher focal length and eye piece of shorter focal length for making a better telescope.

**Experiment 6: Obtain an Image -2**




Fix a lens on a stand. Place a candle on one side of the lens between the focus and center of curvature. How far is the focus of your lens from it's pole? I. E. What is the focal length of your lens?

___

What is the distance between the center of curvature of your lens and it's pole? I. E. What is the radius of curvature of your lens?

___

We have to place a candle at a distance more than focus and less than radius of curvature. Now try to obtain the image on the other side of the lens on a plane paper. How is this image? Smaller, Larger or same as the candle? Is it erect or inverted?

___

How much is the image distance in this experiment?

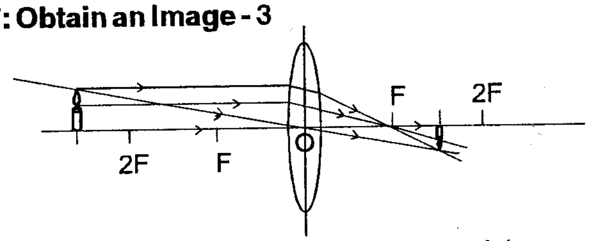
___

Is this image distance more than the center of curvature?

___

Now we will place an object beyond the radius of curvature of a convex lens and try to obtain an image.

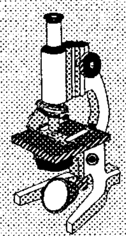
**Experiment 7: Obtain an Image - 3**




Fix a convex lens on a stand. Place a candle beyond the center of curvature on one side of a lens. Now try to obtain the image on the other side of the lens on a plane paper. How is this image? Smaller, Larger or same as the candle? Is it erect or inverted?

___

**Compound Microscope**



The construction of the compound microscope is similar to that of a telescope. But here, the objective is of shorter focal length and eye piece is of longer focal length. The object is placed between the focus and center of curvature of the objective, i.e., the object is placed at a distance which is more than the focal length and less than the radius of curvature.

So now guess how and where would the image of the objective be formed.

This image becomes the object for the eye piece.

This object is at a lesser distance than the focal length but between the focus and the pole of the eye piece. On observing from the other side of the eye piece, the image formed by the objective appears to be larger, virtual and clear.

What is the image distance in this experiment?

---

Is the image distance more than the radius of curvature or less than the focal length?

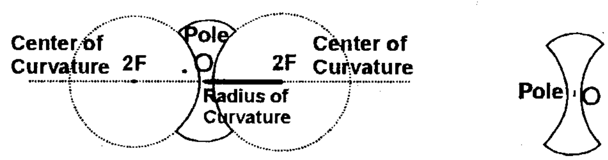
---

Now on the basis of the observations of experiment 3,4,5,6 and 7 fill the information in the following table.

**Table 1: Convex Lens and its Images**

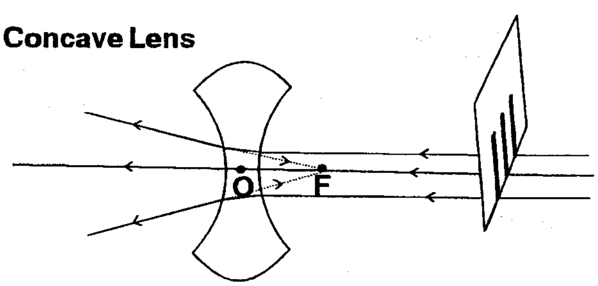
| No. | Position of an object | Position of an image | Nature of the image |
|---|---|---|---|
| 1. | At Infinite distance | | |
| 2. | At the center of curvature | | |
| 3. | Between center of curvature and focus | | |
| 4. | Far from radius of curvature | | |
| 5. | At focus | | |

We did many experiments with convex lens. Now observe the picture given below.




This type of lens is called the concave lens, which is curved inwards from both the sides. Take the concave lens given in your kit. Touch and feel its surface. Come, now let's do an experiment with the concave lens.

**Experiment 8: Concave Lens**




Take again the three slits from Experiment 4. Fix the concave lens on the stand and put it on a plane paper on the floor. As shown in the picture draw line segment AB from the lens. Now with the help of slit allow the parallel rays to fall on the concave mirror. Now observe the rays coming out from the other side of the lens. Do they go away, that is **diverge**, from each other?

---

**More on Lens**

Now you know that on both sides of any lens are present a focus and center of curvature. Thus the lens has two foci and two centers of curvature. The imaginary line passing through the focus, center of curvature on both sides of the lens is called **principal axis.** The light rays parallel to the principal axis get refracted from the lens and pass through the focus on the other side of the lens. The rays passing through the focus on one side of the lens get refracted and become parallel to the principal axis on the other side.

Now put two dots on these rays which are going away from each other. Now draw segment EF, GH,and MN respectively by joining the two dots of each ray. Now extend these three segments on other side of AB till they meet at some point. This is the focus of your concave lens. What is the focal length of your lens?

---

**Short Sight, Long Sight**

At times due to loss of elasticity of the muscles attached to the lens, it cannot become thick or thin. Such an eye is called a defective eye.

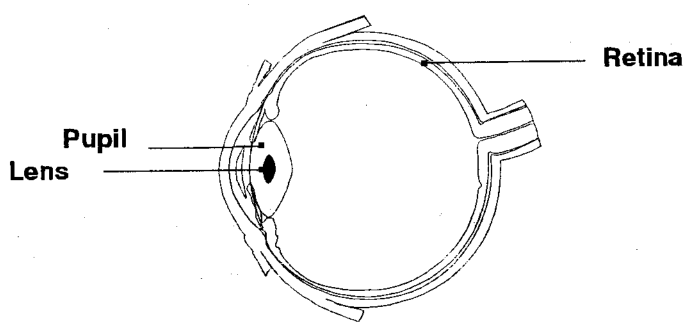
The eye whose lens cannot become thick as per need cannot see near objects clearly. Such a defect is called **far sightedness or long sight.** In the person having this defect, the image of the nearby object is formed behind the retina rather than on the retina. For correcting this defect, one has to wear spectacles with convex lenses of required focal length.

The eye whose lens cannot become thin as per the need, cannot see distant objects clearly. In the person having this defect, called **near sightedness, or short sight,** the image is formed in front of retina instead of falling on the retina.

For correcting this defect, one has to wear spectacles with concave lenses of required focal length.

**Eye**

A human eye is shown in the following picture. It is similar to a camera. On one side there is a lens which acts as a convex lens and on other side there is a retina which acts as a sensitive screen. In front of lens there is a transparent layer called cornea. Behind the cornea there is a small opening or aperture called pupil which controls the amount of light entering the eye. Behind the pupil, the lens is held in position with the help of muscles. The space between the lens and the pupil as well as the space between the lens and the retina is filled with the transparent fluid.




The light rays from the object get reflected and fall on the lens. Here they undergo refraction and get focussed on the retina. To get a sharp image, the lens can be made thicker or thinner with help of muscles attached to it.

# 13 Electricity - 3

**For Every Team**

Bulbs, bulb holders, and cells two of each; six wire pieces, magnetic compass.

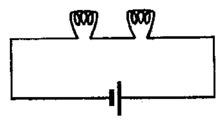
**Note for the Teacher**

Take special precautions while doing experiments in electromagnetism (magnetism caused by electric currents).

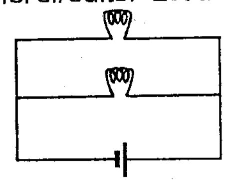
**New Words**

Electromagnetism, static electricity.

In Class 5 and Class 6, we studied many interesting things about electricity. In Class 6, we became familiar with series and parallel circuits. Let us revise a little.



**Picture of Circuit 1**



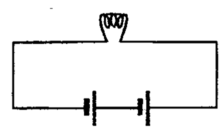
**Picture of Circuit 2**

In the diagrams below, bulbs in which circuit are in parallel and in which one are they connected in series.

In which kind of connection, do the bulbs burn brighter?

**Experiment 1: Cells in Series**

Take a bulb and two cells. Connect them as shown below. Make a note of the brightness of the bulb when connected. This way o connecting the cells is called a series connection of the cells.

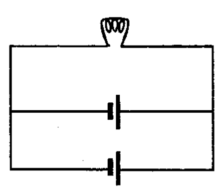


**Picture of Circuit 3**

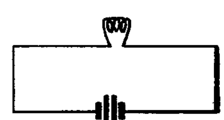
**When the positive of a cell is connected to the negative of a second cell, then they are said to be connected in series.**

**Experiment 2: Cells in Parallel**

Again, take a bulb and two cells. Connect them as shown in the diagram below. Make a mental note of the brightness of the bulb when connected.



Or



**Picture of Circuit 4**

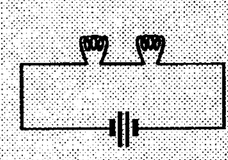
**When the positive of one cell is connected to the positive of a second cell, and at the same time, when the negative of the first cell is connected to the negative of the second cell, then the two cells are said to be connected in parallel.**

From Experiments 1 and 2, can you say which kind of connection of the cells, was the bulb burning brighter?

---

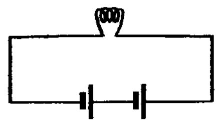
**Connecting Cells in Parallel**

In the above circuit diagram, we show that the positive ends of the two cells are connected to each other. In effect this is the same as the parallel connection shown in the first half of Circuit Diagram 4. Can you see how?

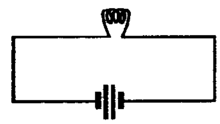


**Experiment 3: Parallel and Series Cell Connections**

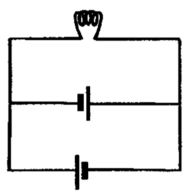
You are given below several circuit diagrams. Can you say in which diagram are the cells are connected in parallel and in which are they in series connection?



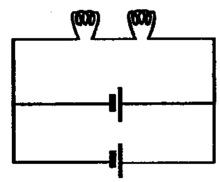
**Picture of Circuit 5**



**Picture of Circuit 6**



**Picture of Circuit 7**



**Picture of Circuit 8**

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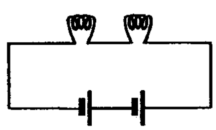
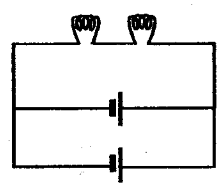
**Experiment 4: What Kind of Circuit is Preferred?**

Look at the circuit diagrams below carefully. As shown, connect two cells and two bulbs.



**Picture of Circuit 9**



**Picture of Circuit 10**

In diagrams 9 and 10, how are the bulbs connected?

---

In diagram 9, how are the cells connected?

---

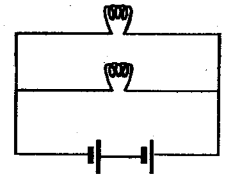
In diagram 10, how are the cells connected?

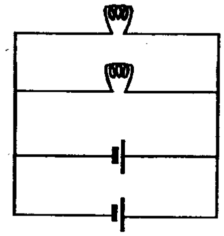
---

**Consider connections given in circuit diagrams 9 and 10: in which one do the bulbs emit brighter light?**

---

**Picture of Circuit 11**





**Picture of Circuit 12**

### How is "Static Electricity" Produced?

Static electricity is produced when one object takes negative charges from another object. For example, rub a plastic comb with your dry hair on your head. And take the comb near a light-weight paper. The paper will jump and stick to the comb.

Static electricity is created when an object gives up or gains negative charges called electrons. Rubbing hair (or wool) over something made of plastic gives that object a positive charge which will attract any object with a lesser charge. The wool gives up electrons to the plastic. This kind of charge is called "static" because it is not moving along a wire or other conductor (but in reality even static electricity has to move! We will discuss this in later classes.).

Another way to "see" static electricity working: Rub a balloon on a wool sweater. The balloon collects negative electrical charges on its surface and the wool collects positive charges. You can then stick the balloon to the wall, which does not have an excess of either charge. The balloon will also stick to the wool, although the charges may jump back to the original material in a short time.

In diagrams 11 and 12, how are the bulbs connected?

---

In diagram 11, how are the cells connected?

---

In diagram 12, how are the cells connected?

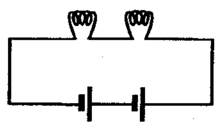
---

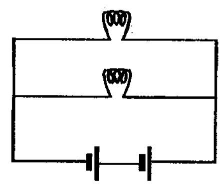
Consider connections given in circuit diagrams 11 and 12: in which one do the bulbs emit brighter light?

---

What can you conclude from the above experiments? How do cells need to be connected so as to have brighter light?

**Picture of Circuit 9**





**Picture of Circuit 11**

In diagrams 9 and 11, how are the cells connected?

---

In diagram 9, how are the bulbs connected?

---

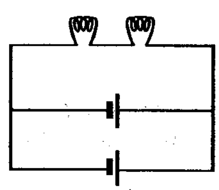
In diagram 11, how are the bulbs connected?

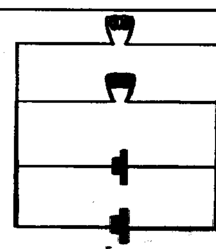
---

Consider connections given in circuit diagrams 9 and 11: in which one do the bulbs emit brighter light?

---

**Picture of Circuit 10**





**Picture of Circuit 12**

In diagrams 10 and 12, how are the cells connected?

In diagrams 10 and 12, how are the bulbs connected?

Consider connections given in circuit diagrams 10 and 12: in which one does the bulb burn brighter?

What can you conclude from the above experiments? How do bulbs need to be connected so as to have brighter light?

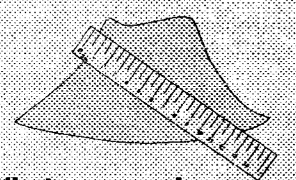
Consider connections given in circuit diagrams in 9, 10, 11 and 12: which gives brightest light?

How are the cells/bulbs connected in the circuit that gives off the brightest light?

Of all circuits using two cells and two bulbs, the brightest light is obtained by connecting bulbs in __________ and cells in ____________.

Of all circuits using two cells and two bulbs, the brightest light is obtained by connecting bulbs in __________ and cells in ____________.

**Bending Water**



**What you need:** a hard rubber or plastic comb, or a balloon, a sink and a water tap.

1. Turn on the tap so that the water runs out in a small, steady stream, less than half a cm thick.

2. Charge the comb by running it through long, dry hair several times or rub it vigorously on a sweater.

3. Slowly bring the comb near the water and watch the water "bend."

4. This experiment can also be done with a balloon.

What happened: The neutral water was attracted to the charged comb, and moved towards it.

**Electromagnetism**

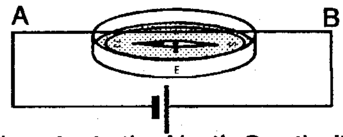
In Class 5 and Class 6 you did many experiments involving electricity and magnets. You will be astonished to know that electricity and magnetism are intimately connected. We will not be able to completely explain these connections in this class; but we will try and understand some interesting results because of this relation between electricity and magnetism.

A flowing electric current results in magnetic effects; in fact behaves like a magnet. This fact was discovered almost 200 years ago -- in 1819 actually -- by a Danish scientist called Oersted. We will do below the path-breaking experiment Oersted did.

In Class 6, you did an experiment on chemical electroplating and you learnt that electroplating is a result of electric current that flows in the same direction as the copper ions: that is from the positive to the negative of the cell.

**Experiment 5: Oersted's Experiment -1**

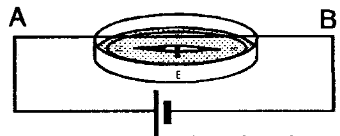
Take a magnetic compass and keep it on a level surface. Build a circuit as shown in the picture below.




Keep the segment AB of the wire in the North-South direction such that the wire passes over the compass and coincides with the needle. Complete the circuit with the wire segment AB in this position. Show the direction of current flow in the picture by drawing an arrow in the picture above. Did you observe any effect on the direction of the needle of the compass when the current started flowing? In which direction did the north pole of the needle move?

---

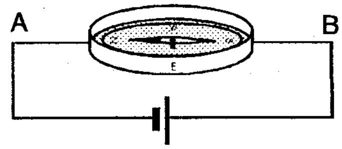
While noting your observations, remember that the direction of the current flow is **from the positive to the negative end of the cell.** Now reverse the cell connections and repeat the above experiment.




Again point out the direction of current flow by drawing an arrow in the picture above. Did you observe any effect on the needle once the circuit was completed? In which direction did the north pole of the needle move this time around?

---

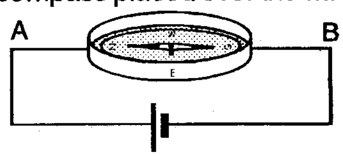
Again restore the connections of the cell to its previous position but this time the compass is placed over the wire (as shown in the picture below).




Point out the direction of current flow by drawing an arrow in the picture above. Did you observe any effect on the needle once the circuit was restored to its previous position? In which direction did the north pole of the needle move this time?

---

Do the reversing cell connections procedure once again (connection should be like in picture below with compass placed over the wire).

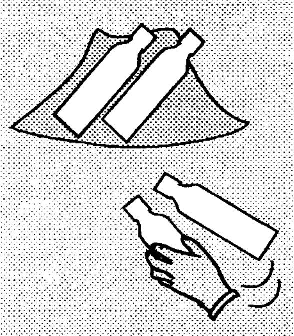



Again point out the direction of current flow by **drawing an arrow in** the picture above. Did you observe any effect on the **needle once the cell connections** were again reversed? In which direction did **the north pole of the needle** move this time?

---

Write your observations in **Table 1 below.**

**Try this experiment!**

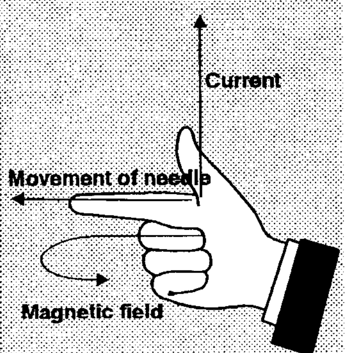


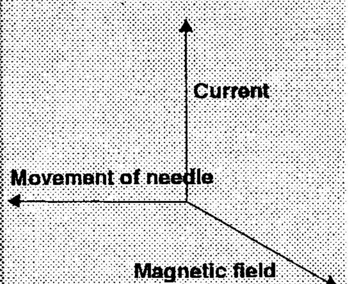
Rub two plastic bottles on the same cloth. Bring the bottles near each other. They repel!

This is because in both bottles the same type of charges have been taken out and therefore they have "like" charge imbalance. Like electric charges repel.

**Table 1**

| Direction of Current Flow in Wire Segment AB | Wire Segment AB Above or Below the Compass? | Direction of Movement of the Magnetic Needle |
|---|---|---|
| North to South | Above | |
| South to North | Above | |
| North to South | Below | |
| South to North | Below | |




Try and answer the following questions on the basis of what you have entered in the Table.

When wire AB is *above* the compass needle and the current flows from North to South, towards what direction does the North Pole end of the compass needle turn?

---

When wire AB is *above* the compass needle and the current flows from South to North, towards what direction does the North Pole end of the compass needle turn?

---

When wire AB is *below* the compass needle and the current flows from North to South, towards what direction does the North Pole end of the compass needle turn?

---

When wire AB is *below* the compass needle and the current flows from South to North, towards what direction does the North Pole end of the compass needle turn?

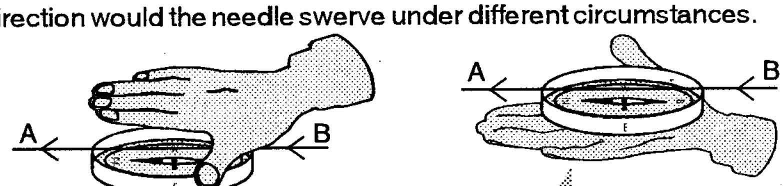
---

You of course know that the magnetic compass uses a magnetized needle. Therefore if any other magnet is brought near the needle there is sharp movement of the needle. In the above experiments, you have seen that the direction of the compass needle moves similarly on the flow of the current. Can we therefore say that a wire carrying an electric current behaves like a magnet?

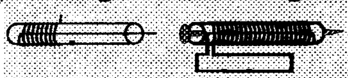
---

**Right Hand Rule**

It must be fairly clear to you by now that a flowing electric current results in the wire having magnetic properties and the direction of the compass needle is affected just like when any magnet is brought near it. The *right hand rule* gives in what direction would the needle swerve under different circumstances.



**Building an Electromagnet**



It is fairly easy to build an electromagnet. All you need to do is wrap some insulated copper wire around an iron core. If you attach a battery to the wire, an electric current will begin to flow and the iron core will become magnetized. When the battery is disconnected, the iron core will lose its magnetism.

Take a strip of paper 7-8 cm wide and 20 cm long. Spread some sticking gum on one side of the paper strip. Keep the sticky side facing up and wrap the paper around a pencil. Take out the pencil gently. Let the gum, etc. on the paper dry out.

See that the circular spirals do not sit on each other. Now insert a long nail inside this "paper-wire cylinder". Now take a 4 meter long wire. Wrap the wire neatly around the dried paper cylinder with the nail in it -- about a 100 times around as shown in the picture. Join this paper-wire-nail cylinder as part of the circuit. Place some pins nearby. Complete the circuit. When electricity flows in the wire, a magnetic field is created around the paper-wire cylinder.

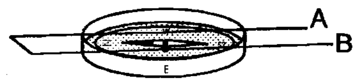
Can you guess what happens to the pins?

If the fingers of the right hand point along the direction of current flow in the wire from positive towards the negative side, the magnetic needle moves in the direction indicated by the thumb of the right hand. Please ensure that when the wire is above the compass needle, your palm too is above the compass needle; and when the wire is below the compass needle, your palm too is below the compass needle (see picture above).

Check out the validity of this rule by actually testing it.

**Experiment 6: Oersted's Experiment - 2**

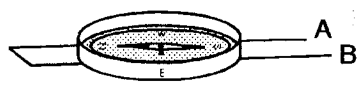
Set up the above experiment again. Make a u-shape of the wire as shown below. Keep the u-shaped wire *on* the compass. And complete the circuit as before.




Show the direction of current flow in the diagram by appropriate arrows. Is there any effect of the current on the needle? If the needle did move, in which direction did the North Pole of the needle move?

---

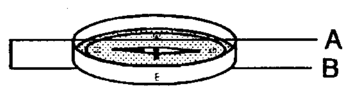
Repeat the above experiment but now keep the u-shaped wire *below* the compass. And complete the circuit as before.




Show the direction of current flow in the diagram by appropriate arrows. Is there any effect of the current on the needle? If the needle did move, in which direction did the North Pole of the needle move?

---

Repeat the above experiment but now keep the part of the u-shaped wire *below* the compass and part *above* (see picture below). And complete the circuit as before.




Again show the direction of current flow in the diagram by appropriate arrows. Is there any effect of the current on the needle? If the needle did move, in which direction did the North Pole of the needle move?

---

# 14 Human body

**Things You Need**

Scissors, Bottles, iodine solution

**For Every Group**

Injection bottle, iodine solution, wheat flour, water, a glass with a hole, empty refill, thread, balloon, test tube, two- holed cork, 2 glass tubes, funnel, rubber tube, 1-2 litre capacity glass jar.

**New Words**

Digestive system
Oesophagus
Stomach
Intestines
Liver
Pancreas
Gall bladder
Respiratory system
Trachea
Tracheal
Air sac
Circulatory system
Red blood cells
White blood cells
Blood platelets
Aorta
Vena cava
Pulmonary
Artery
Vein
Arteriole
Venule
Heart
Auricle
Ventricle
Excretory system
Kidney

We learned so far the science of how things around us function. Over the years, humans discovered the science of living and non living things. We will learn in this chapter how the body and systems of human beings work.

Can you write the functions of the following parts of the body? What do they do and how do they help us in our day to day lives?

Eye:

Ear:

Hand:

Leg:

Brain:

Stomach:

Heart:

Lungs:

Ribs:

Nose:

Eye:

Brain:

Hand:

Mouth:

Tongue:

Is any part more important than the other?

Let us now find out what happens to the food once it is taken into the mouth. Le us try and find out with this activity.

**Experiment 1: Digestion of Food in Mouth**


Kidneys
Urinary bladder
Ureter
Nervous System
Cerebrum
Cerebellum
Medulla oblongata
Nerve
Spinal cord
Muscular system
Skeletal system
Bone
Skull
Ribcage
Vertebral column
Sternum
Ribs
Clavicle
Pelvic bone
Femur
Tibia and fibula
Patella
Humerus
Radius and ulna
Elbow
Wrist
Carpels
Metacarpels
Phallanges
Joint

Take two empty injection bottles, add a pinch of wheat flour in each. Fill one-fourth of each of the bottles with water and shake properly. Label one bottle as A and other as B. Now start adding saliva to bottle A till it is half full. Now close both the bottles with a cork and shake vigorously. Keep them for half-an-hour. Now add 2-3 drops of iodine solution to both the bottles and shake well.

Which of the bottles shows dark blue or black colour?

________________________________________

From this observation can you tell which nutrient is present in wheat flour?

________________________________________

Which bottle does not show dark blue or black colour?

________________________________________

From this observation, do you think the starch present in wheat flour has disappeared?

________________________________________

Besides wheat flour and water, what else, did we add to bottle A?

________________________________________

When the saliva mixes with food, the starch present in the food is digested and it is converted into simple sugar like glucose. Thus, we see that the digestion of the food begins in the mouth once it mixes with saliva. It is this conversion of starch to sugar which makes the food taste sweeter.

All the organs which take part in digestion of food together form digestive system. Come, let us do an interesting activity to identify the parts of digestive system.

On page 95, you are given a human figure, with functions of different digestive organs. The different parts of digestive system are given on page 97.

On completion, study each organ and its function and answer **the following** questions. Name all the organs of the digestive system.

________________________________________

________________________________________

________________________________________

________________________________________

Write the functions of tongue and teeth.

________________________________________

________________________________________

What is the function of the food pipe?

________________________________________

________________________________________

What happens to the food in stomach?

________________________________________

________________________________________

Sometimes after a meal, we get burps that leave a sour taste in the mouth; do you why?

________________________________________

________________________________________

________________________________________

Write the functions of liver, pancreas and gall bladder.

________________________________________

________________________________________

What happens to food in the small intestine?

________________________________________

________________________________________

What happens to food in the large intestine?

________________________________________

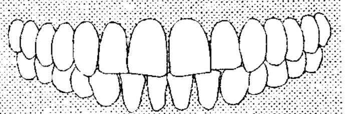
________________________________________

Liver produces bile juice which is stored in gall bladder. From there, **bile duct** carries it to small intestine. Here, bile juice breaks down **the fats into small** globules for easier digestion.

Pancreas produces pancreactic juice which contains **digestive enzymes** namely amylase, trypsin, lipase.

Pancreatic juice is carried to small intestine through **pancreatic duct. In the** small intestine, the digestion of starch proteins and fats is **completed**.

### Types of Teeth



An adult human has total 32 teeth. Out of which 8 are incisors(used for nibbling, cutting),4 are canines (used for tearing), 8 are pre-molars and 12 are molars (used for grinding and chewing).

### Uses of Food

The food we consume is used for:

(1) Providing heat and energy to the body.

(2) Providing energy to each and every cell.

(3) For repair of worn out cells.

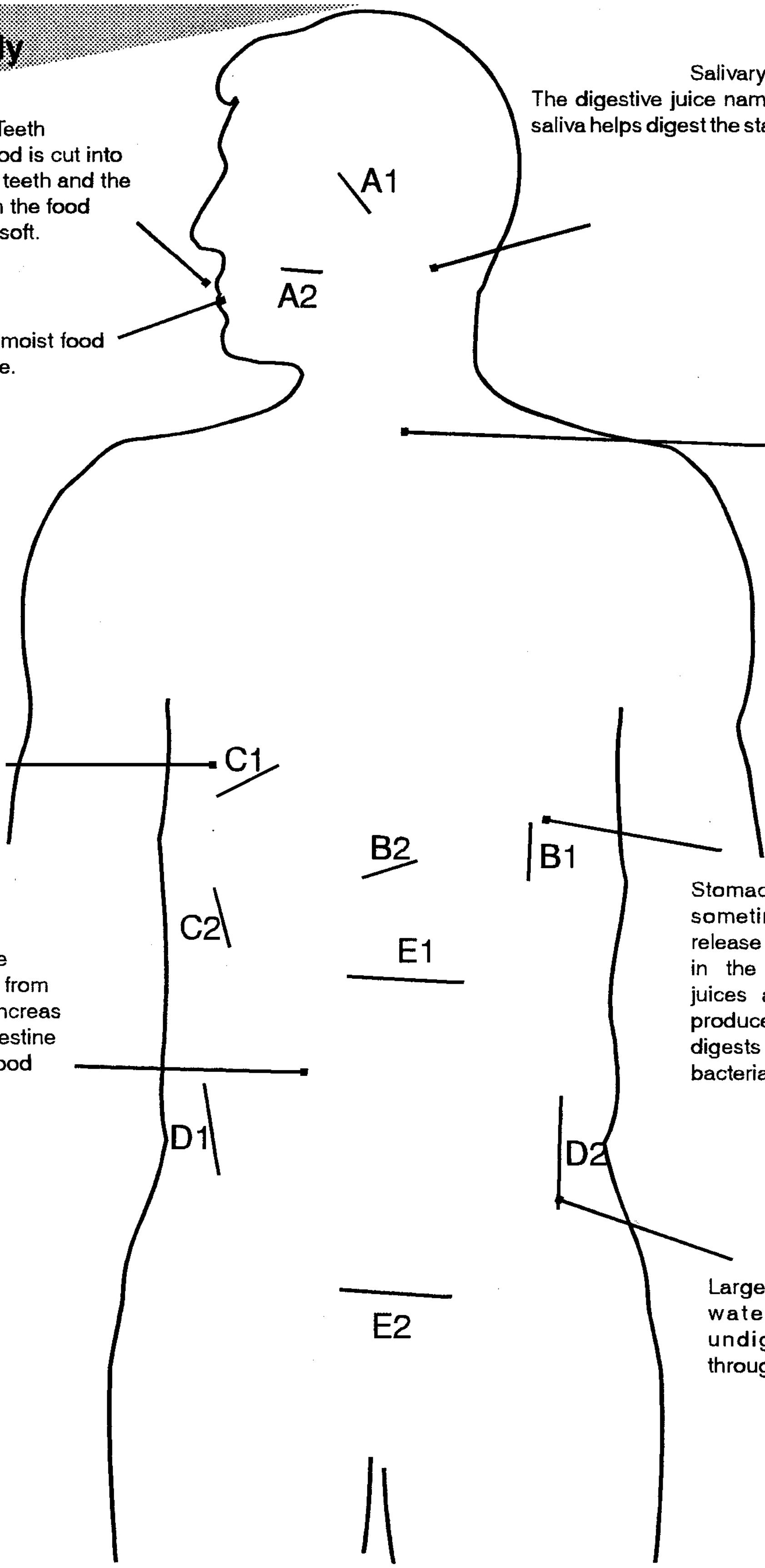
# Human body

Mouth/Teeth
Inside the mouth food is cut into small pieces by the teeth and the mixing of saliva with the food makes it moist and soft.

Salivary gland
The digestive juice named amylase present in saliva helps digest the starch present in food.

Tongue
Tongue pushes the moist food towards the food pipe.

Oesophagus
It pushes the food towards the stomach by contraction and expanpansion of its muscles.

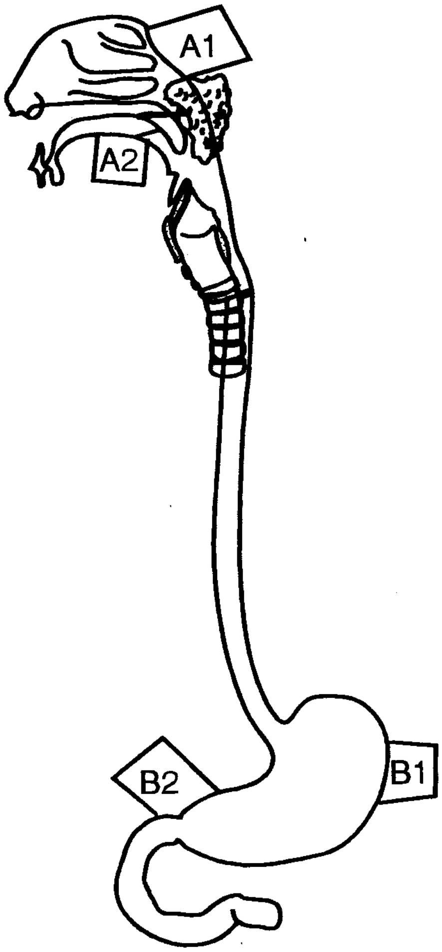


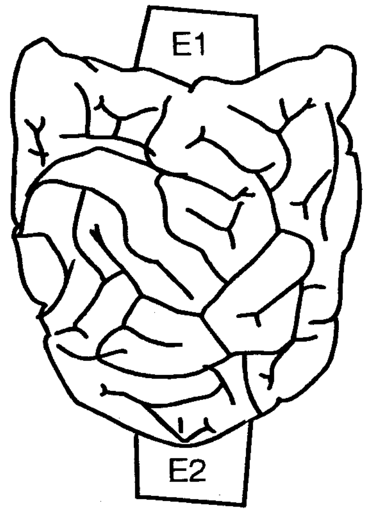

**Liver**
Bile juice is produced in liver which digests fat present in food.

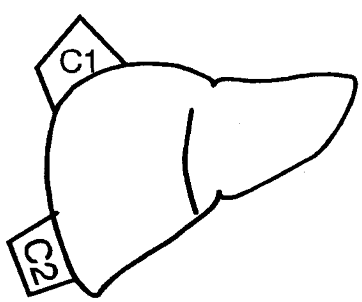
Stomach
Stomach stores the food for sometime and regulates the release of proper amount of food in the intestine. The digestive juices and hydrochloric acid is produced in the stomach which digests the food and kills the bacteria.

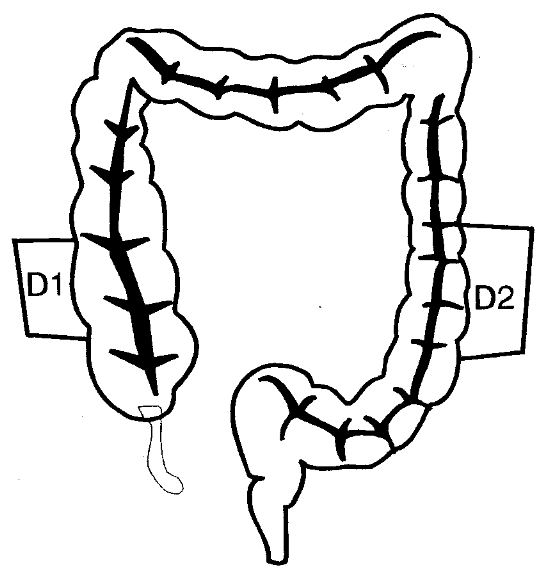
Small intestine
The digestive juices from gall bladder and pancreas are released into intestine - they mix with the food and help digest it.

Large intestine
Large intestine absorbs the water and removes the undigested food material through anus.


A1
A2
B2
B1


E1
E2


C1
C2


D1
D2

**A conversation between some parts of the body**

Legs : This digestive system has done a lot of work. I think now **I will have to** go for a walk now.

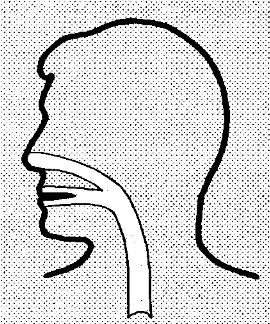
Brain : It is the digestive system which is giving you energy (**legs go for a** long walk).

Nose : Look! Legs have gone for a walk but because of them why **do I have** to breathe so fast ?

Lungs : Oh ! You will have to hurry up. I have to supply oxygen to the **blood** very quickly.

**Importance of Nose**

Take a small thread or cotton wick. Put it in your nose and twist it around. What happened ? Did you sneeze ? Why did you sneeze? Think, what all makes you sneeze? Why does it happen ? When any dust particle or irritant enters our nose, the body tries to throw it out by sneezing. Fine hairs are present inside the nose which filters the air. Inside the nose, there is a secretion of sticky substance called mucus which traps dust particles and micro organisms present in the air. Thus, it prevents their entry into the lungs.



Let us understand why lungs have to speed up their activity through an experiment.

**Experiment 2: How many times do we breathe in a minute ?**

Bring your finger near your friend's nose in such a way that the nail is facing upwards. Ask your friend to breathe in and out normally. What do you feel on your finger when he breathes out ?

___

Now, count how many times does he breathe out in a **minute? Did he** breathe in as many times as he breathed out in a minute?

___

Breathing in the air is called **inhalation** and releasing the air is called **exhalation**. Breathing combines both inhalation and exhalation. How many times do you breathe in a minute ?

___

**Breathing rate is the number of times you breathe in a minute.**

After running why do we need to breathe fast ?

___

___

When we do hard work, our body uses more energy . This increases the need for oxygen which in turn increases breathing rate.

By now you must have understood that the process of taking in air is inhalation and releasing is class exhalation. The organs involved in process of breathing together forms a respiratory system. Le us do an interesting activity to identify the organs of the respiratory system.

On Page 103, a human figure has been given to you in which functions of different organs of respiratory system are given. On Page 105, different organs of respiratory system are given. You have to arrange the different organs at the appropriate places.

After arranging each organ, study and understand the respiratory system and answer the following questions.

List the respiratory organs.

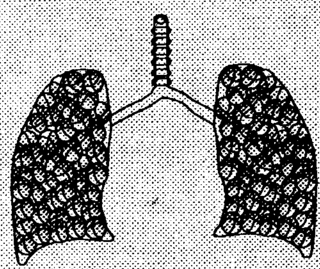
____________________

____________________

____________________

____________________

Alveoli



In the lungs, there is a capillary network surrounding the alveoli. The oxygen from the air taken in by the nose diffuses from the alveoli in to the blood in the capillary network through their thin walls. Similarly, the carbon dioxide from the blood (in the capillary network) enters the alveoli of the lungs. By this gaseous exchange carbon dioxide collected in the alveoli is removed from the body through exhalation.

Write the importance of nose in the respiratory system.

____________________

____________________

What is the function of trachea?

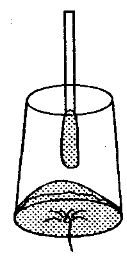
____________________

What are the innumerable smallest units of the lungs called?

____________________

Let us perform an experiment to understand how lungs function.

**Experiment 3: Process of Respiration: how does it occur?**



Take a transparent plastic glass and make a small hole in its base. Tie a balloon on one end of a used refill in such a way that you can blow air from the other end. Place the refill in the glass so that the open end of refill comes out through the hole. Seal the space around the hole with hot wax, so that no air can enter in or come out. Take another balloon and cut off its neck, put a green gram in the lower portion and tie the seed with a thread. Stretch this balloon over the mouth of the glass and tie it with a string as shown in the figure above. Now pull down the string used to tie the green gram.

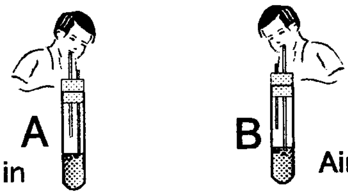
What happens to the balloon tied to the refill ? Does it blow out ? Where did it get the air inside from ?

---

This is exactly what happens in our body. The balloon in the experiment is comparable to the lungs in our body, the only difference being that we have two lungs. If we tie the balloons to an inverted Y shaped (λ) tube, we will get a model similar to our lungs. The process of respiration occurs because of contraction and expansion of the muscles between the ribs and the diaphragm.

Now let us do an experiment to find the nature of the gas present in the inhaled and exhaled air .

**Experiment 4: What do inhaled and exhaled air contain ?**




Collect the things required for the experiment as shown in picture. Dissolve some lime (chuna) in water. Allow it to settle down and then fill one-fourth of both the tube with clear lime solution. Label one tube as **A** and other as **B.** Fix the glass tube and the corks as shown in the picture. Now suck the air from tube **A** and blow in air in tube **B**. Now answer the following questions.

When we breath in through mouth, from which test tube does the air go in (the mouth ) ?

---

When we breath out, from which test tube does the air goes out or is removed?

---

In which tube does the solution turn milky? What was in the air that was blown in to the tube? Was it the inhaled or exhaled air?

From this experiment, you must have understood the difference between inhaled and exhaled air.

---

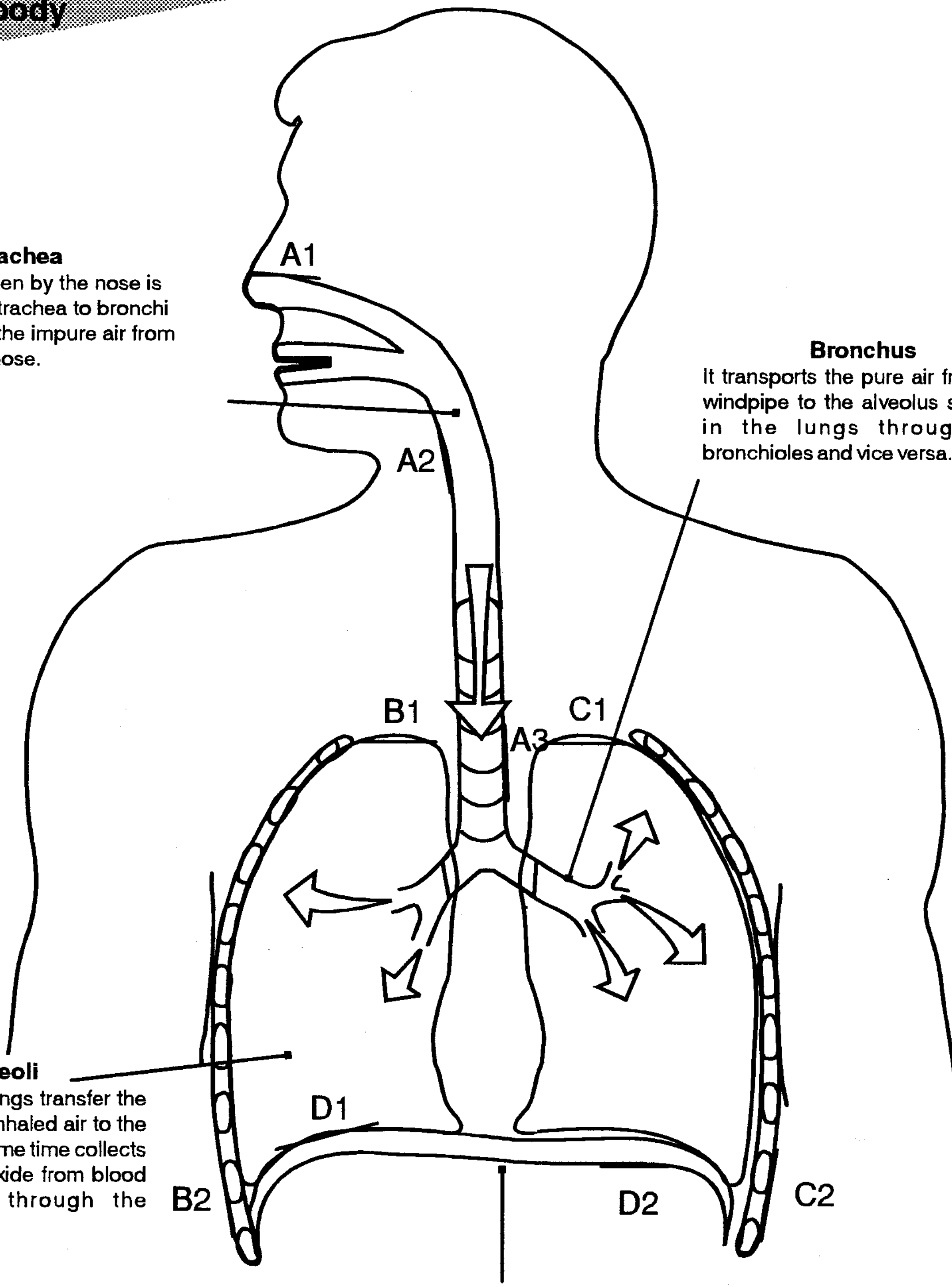
---

On the basis of the above experiment, we can say that as compared to the inhaled air, exhaled air has less amount of oxygen, and more of $CO_2$.

**Strength of your Lungs**

Fill a bucket with the water. Fill a calibrated (marked 1,2,3......at regular intervals) wide mouth jar with water up to the brim. Now invert it into this bucket. Now, lift this inverted jar a little. Now put one end of rubber tube inside the jar. Take a deep breath and then take the second end of the tube in your mouth and blow out as hard as you can.

When the air sacs (alveoli) are filled with air, the chest expands and the stomach bulges out. When the air is removed, the chest contracts and stomach also goes in. During breathing, it is essential that the stomach should contract and expand. Only when/if this happens, we say that we are breathing in and out enough air. Deep and slow breathing is much healthier than breathing fast.




**Trachea**

The pure air taken by the nose is transported by trachea to bronchi and transports the impure air from bronchi to the nose.

**Bronchus**

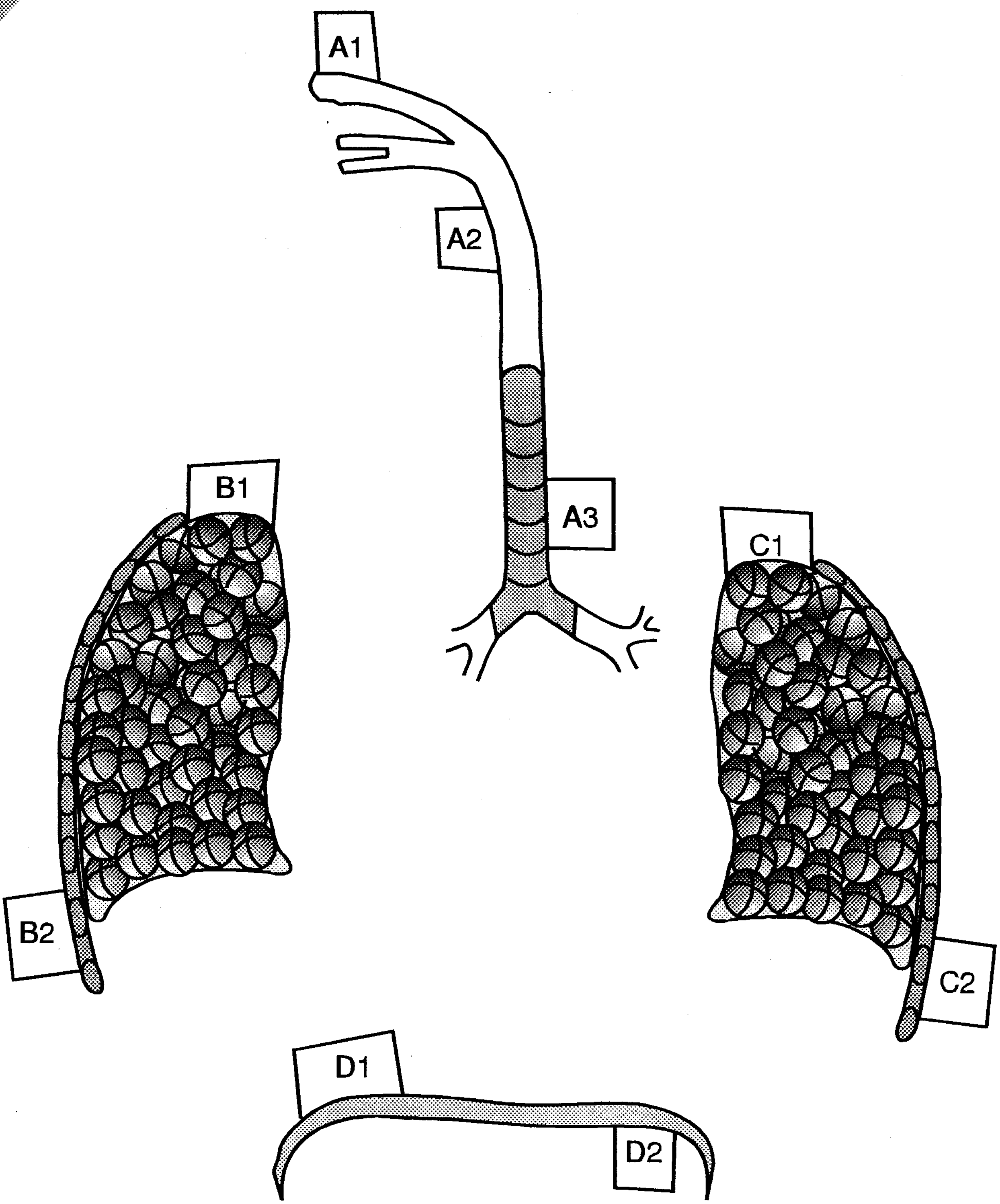
It transports the pure air from the windpipe to the alveolus situated in the lungs through the bronchioles and vice versa.

**Alveoli**

Alveoli of the lungs transfer the oxygen of the inhaled air to the blood, at the same time collects the carbon dioxide from blood for removal through the trachea.

**Diaphragm**

The process of breathing is carried out by the expansion and contraction of the diaphragm.When the diaphragm expands, the lungs are filled with air and when it contracts, the air is exhaled.


A1
A2
A3
B1
B2
C1
C2
D1
D2

## More Conversation

Lungs: Oh! Why are you making 'lub dub' sound. It's me who has **done the** work.

Heart: Look at that! I had to pump the blood purified by you.

Blood: Why are you arguing needlessly? You both get free after you finish your only job. But I have to keep circulating through the whole body. The system which circulates the blood in the body is called the circulatory system. Come, let us do an interesting activity to understand the circulatory system.

On Page 109, you are given a human figure with the circulatory system. Study the different parts and their functions and answer the following questions. Name the different parts of the circulatory system.

________________________________________

________________________________________

________________________________________

________________________________________

What is the function of aorta?

________________________________________

________________________________________

________________________________________

What is the function of the vena cava?

________________________________________

________________________________________

________________________________________

What is function of the pulmonary artery?

________________________________________

________________________________________

________________________________________

What is the function of the pulmonary vein?

________________________________________

________________________________________

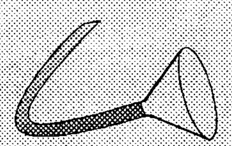
________________________________________

________________________________________

**Write the function of the** heart.

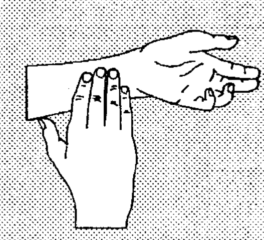
### Experience your Heart Beat

Take a glass or plastic funnel and fit a rubber tube at it's end. Place the funnel on the left side of your chest and put the rubber tube in your ear. Close the other ear and listen to the sound. Count the number of heartbeats in the minute. You will be able to hear heartbeats by placing your ear on your friend's chest.

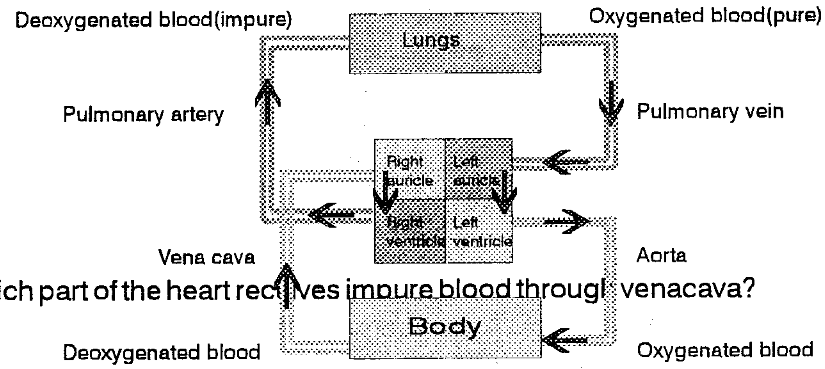


### Feel Your Pulse

Place three fingers of your right hand on the left wrist as shown in the figure. Count the number of pulses in a minute. We can feel the beats of any artery on the body surface. We can feel the beat or pulse due to contraction and relaxation of the heart.



With the help of the following diagram, let us try to understand how the blood is circulated in the body.




Which part of the heart receives impure blood through venacava?

From which part of the heart is pure blood supplied to the body through aorta?

---

Which part of the heart receives pure blood from the lungs through pulmonary vein?

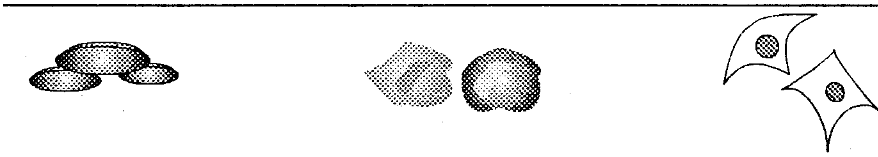
---

From which part of the heart is the impure blood taken to the lungs through pulmonary artery?

---

Now, let us try to understand what all is there in our blood. Here, you are given the figures of different types of blood cells.

---



The RBCs, platelets, and WBCs are required by the body. They are circulated in the body by blood plasma which is a yellowish fluid. Now answer the following questions.

The property of the blood to solidify is due to which type of cell?

---

The red colour of the blood is due to which type of cell?

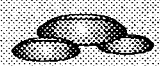
---

The heamoglobin in the erythrocytes gives it a red colour and that is why they are also called red blood cells.

Which blood cells protect our body against germs?

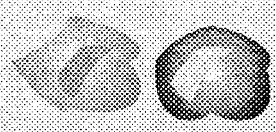
---

**Red Blood Cells**



RBCs contain the pigment called haemoglobin which binds to the oxygen. RBCs transports the oxygen in the body.

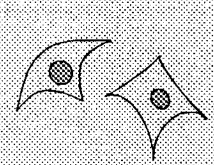
**White Blood Cells**



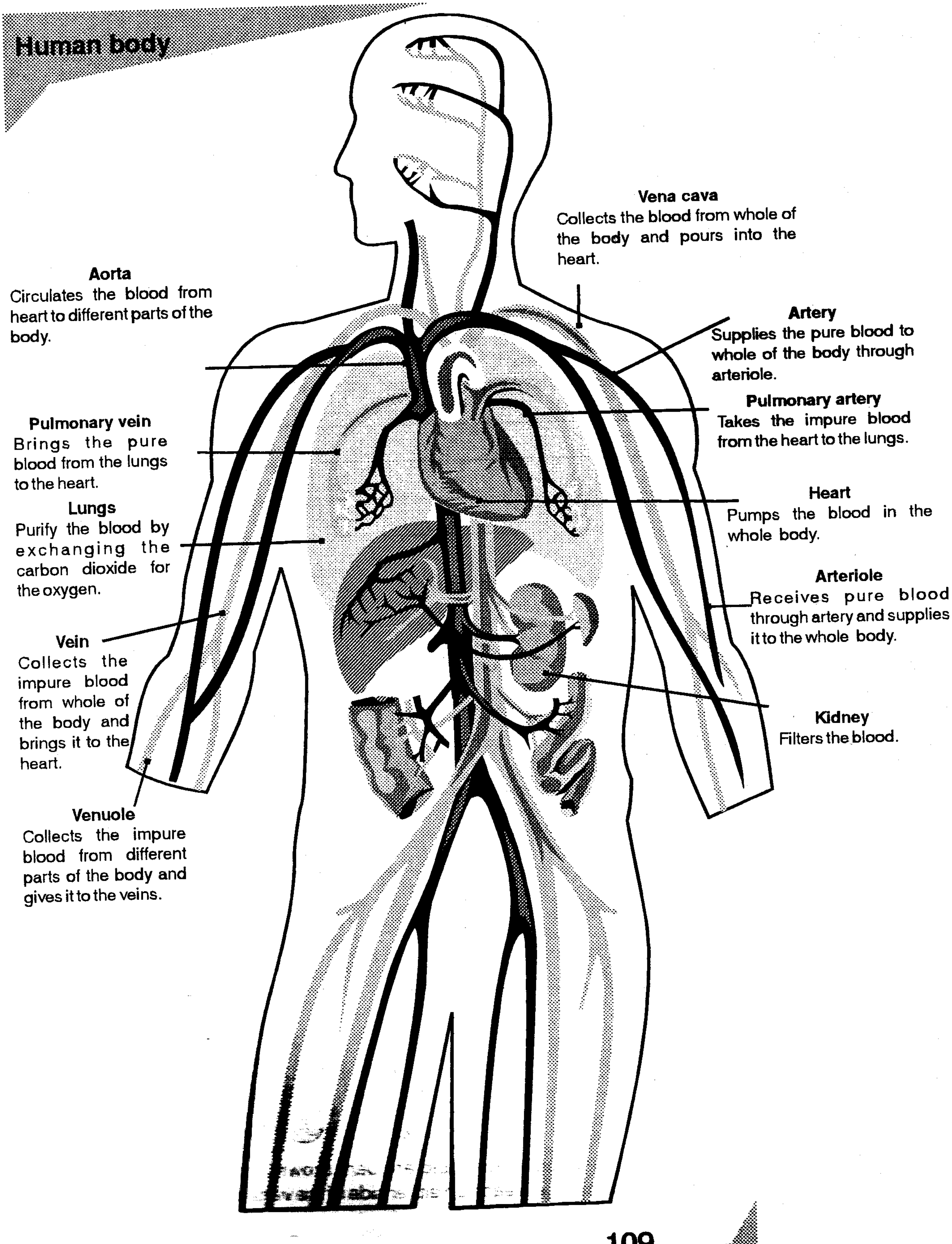
WBCs are larger in size compared to RBCs, but are less in number. They kill the bacteria and protect the body against the infections.

**Platelets**

Platelets are smallest in size and are irregular in shape. They help in clotting of the blood.



# Human body



Vena cava
Collects the blood from whole of the body and pours into the heart.
Aorta
Circulates the blood from heart to different parts of the body.
Artery
Supplies the pure blood to whole of the body through arteriole.
Pulmonary vein
Brings the pure blood from the lungs to the heart.
Pulmonary artery
Takes the impure blood from the heart to the lungs.
Heart
Pumps the blood in the whole body.
Lungs
Purify the blood by exchanging the carbon dioxide for the oxygen.
Arteriole
Receives pure blood through artery and supplies it to the whole body.
Vein
Collects the impure blood from whole of the body and brings it to the heart.
Kidney
Filters the blood.
Venuole
Collects the impure blood from different parts of the body and gives it to the veins.

### Still More Conversation

Blood: Oh, look ! how much waste have I gathered from this whole day's workout !

Lungs: I eliminate the waste in gaseous form from you.

Blood: Yes you do but ...

Kidney: And I remove the waste in liquid form from the blood.

The system which removes the waste in liquid form from the body is known as the Excretory System. Come, let us do an interesting activity to understand excretory system.

On Page 111, you are given a human figure with the function of individual organs of excretory system. On Page113, different organs of excretory system are given. Arrange the different organs in the human figure in their appropriate places. Once you have arranged all the parts, study their functions and answer the following questions.

Name the different parts of the excretory system.

________________________________________

________________________________________

________________________________________

________________________________________

State the functions of the kidney.

________________________________________

Name the numerous units present in the kidney.

________________________________________

________________________________________

What is the function of the ureter?

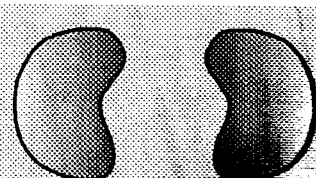
________________________________________

________________________________________

State the function of urinary bladder.

________________________________________

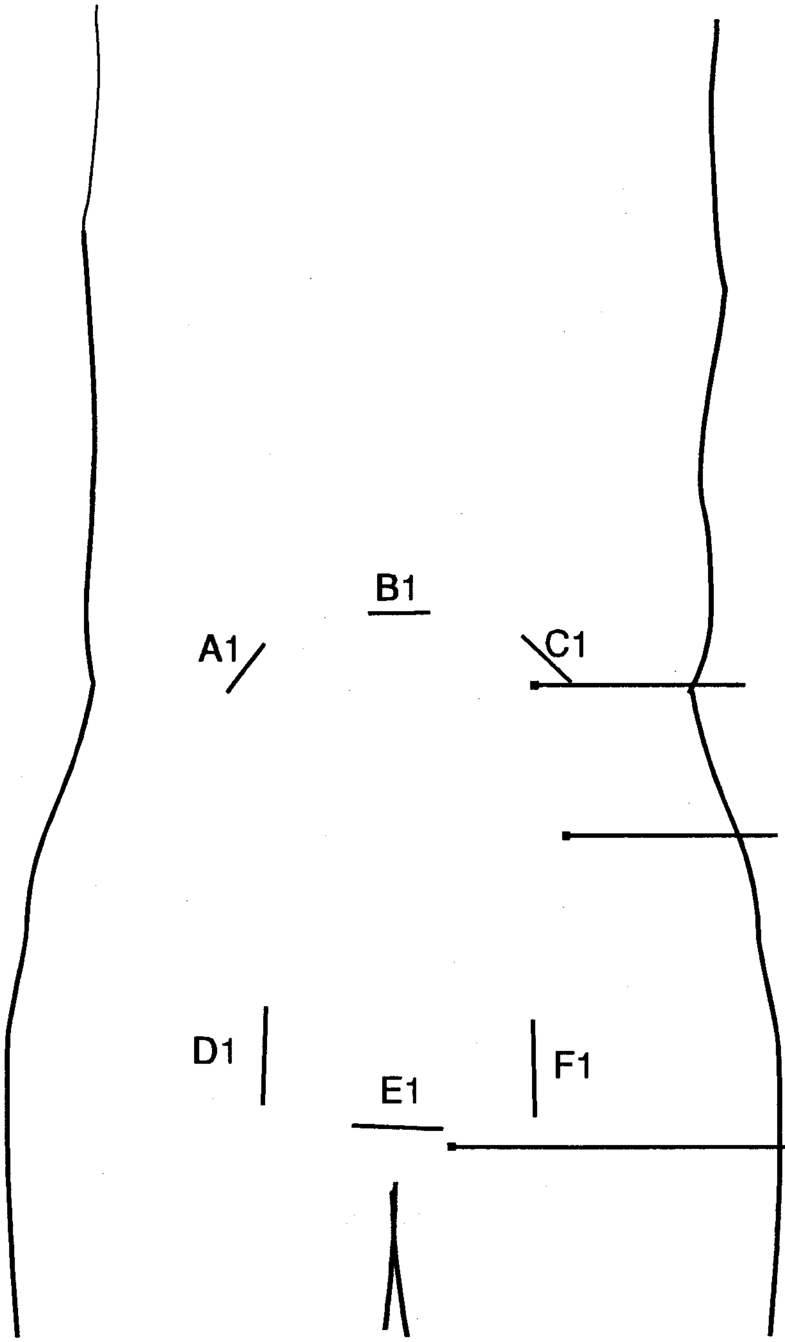
________________________________________



Kidneys are bean shaped and are dark brown in colour. They are located behind the stomach each on either side of the vertebral column.

**Excretory System**

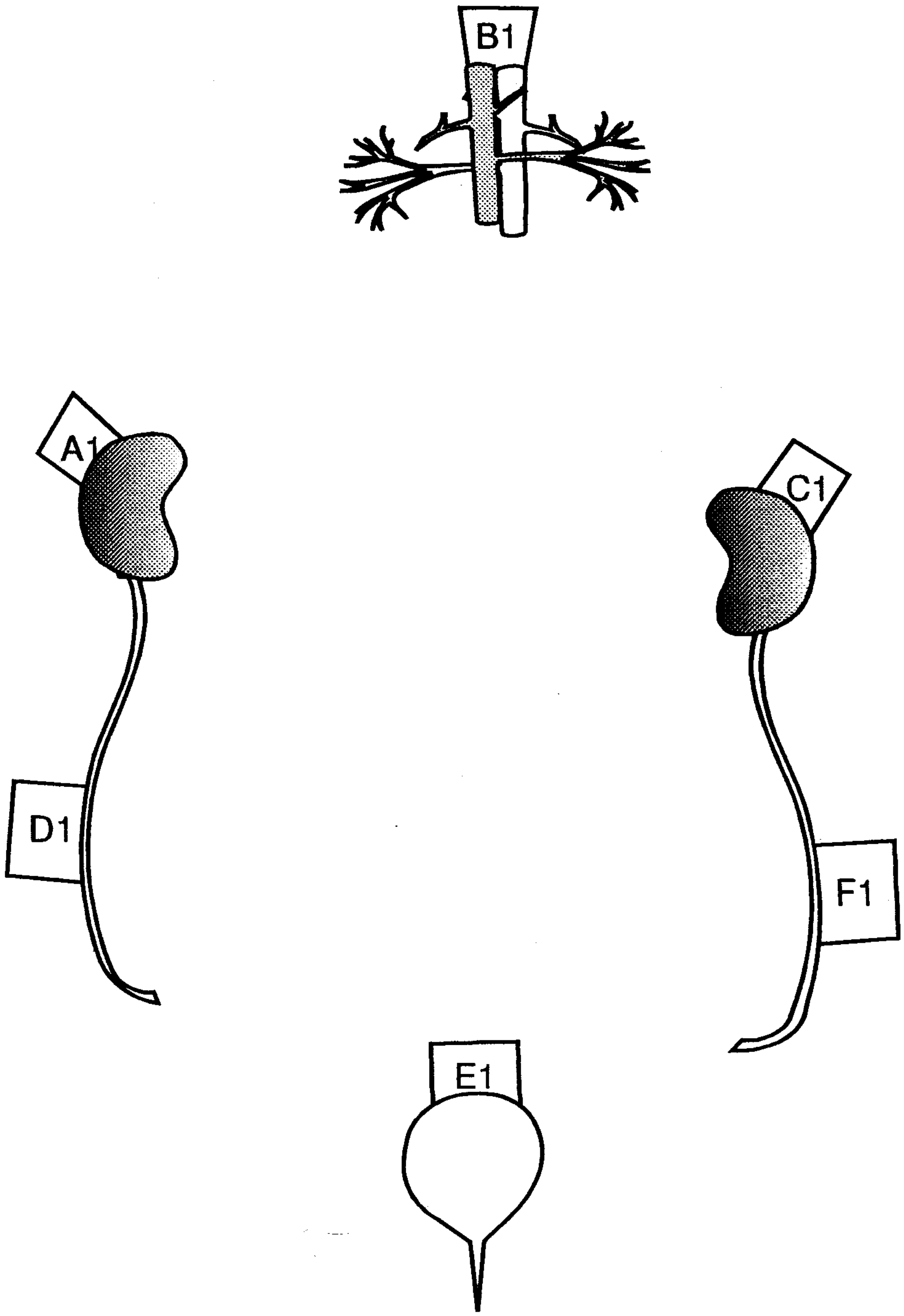
Kidneys filter unwanted waste from the blood. Kidneys are made up of numerous units called nephrons. One end of nephron is funnel shaped which contains a capillary network. There is a difference in the diameter of the capillaries of the nephron and the surrounding blood vessels which results in difference in the blood pressure. It is due to this difference that the waste from the blood is filtered out from the nephron and carried to the urinary bladder through ureters.




**Kidney**
Filters various mineral salts and water from the blood.

**Ureter**
Transports urine from kidney to the urinary bladder.

**Urinary bladder**
Stores urine for sometime and then removes it through urinary tract.


B1
A1
C1
D1
F1
E1

# Human body

**And more body part talk**

Blood: Why do I only have to supply nutrients to the various **parts of the body?**

Heart: Why do I have to pump the blood? Who tells me to **do that?**

Stomach: And How do I start churning the food as soon as it **reaches me? I** wonder who tells me to do that?

Spinal cord: Hey guys! You should all thank Mr. Brain for this. He is **the one who** is managing the whole body.

The system which regulates the working of all the systems is known as the Nervous System.

In the adjacent screen, the different parts of brain are shown along with their functions. Read the screen and answer the following questions.

Name the different parts of nervous system.

________________________________________

________________________________________

________________________________________

________________________________________

State the function of left and right brain.

________________________________________

________________________________________

State the function of spinal cord.

________________________________________

State the function of nerves.

________________________________________

________________________________________

Nerves on the basis of their function are grouped into three categories.

Sensory nerves- convey the information from sensory organs to the brain.

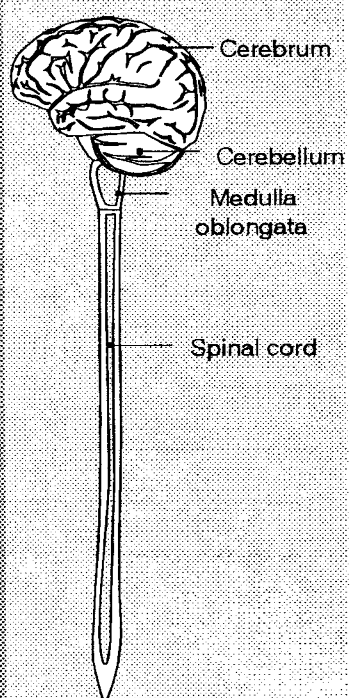
Motor nerves- convey the information from brain and spinal cord to different parts of the body.

Mixed nerves-Do the function of both motor and sensory nerves.

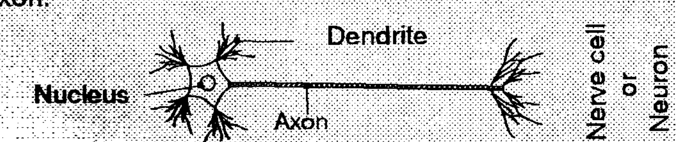
**Nervous System**

The brain controls the various functions of the body. The sensory nerves from various parts of body carry messages to the brain. The motor nerves carry the orders from the brain to various parts of the body to perform the proper task at the right time. These nerves combine together and form a spinal cord,

Left side of the brain controls right side of the body and vice a versa.




The functional unit of nervous system is called neuron or nerve cell. It consists of three main parts: cell body, dendrites and axon. Cell body contains nucleus, from the cell body emerge many small fibres called dendrites and one long fibre called axon.



**And yet more body part talk**

Brain: Some times I also feel tired doing all this.

Stomach, Heart, Kidneys, Lungs: So think, what would be our condition? At times we feel, we will tumble down from our places.

Bones & Muscles: But you will fall only if we let you do so!

The system which protects the delicate parts of other systems and supports them is called Skeletal system.

Come, let us do an interesting activity to study the skeletal system.

On Page117, you are given a human figure, and on Page 119, different parts of skeletal system are given. You have to arrange the different parts at their proper places. Once you finish with that activity, study the different parts and get an idea of skeletal system.

**Some interesting facts**

Strength of bones - generally the thigh bone can take weight approximately equal to the weight of 30 human beings.

Smallest bone - Stapes present in the middle ear is the smallest bone. The lenght of this bone is 2.6 to 3.4 mm.

Vertebral column - it consists of the following vertebrae.
Seven(7)-cervical (neck vertebrae)
Twelve(12)- thoracic (chest vertebrae)
Five(5)- lumbar vertebrae
Five(5)- sacral vertebrae
Four(4)- coccyx (tail vertebrae)

Human ribs - usually there are 12 pairs of ribs in human body.

Longest bone - Thigh bone is the longest bone in humans.

Soft bones (cartilagenous bones): Press your ear with your hand. Is your ear uniformly hard? The hard portion of your ear is made up of special kind of soft bone. Observe your body and tell which part of your body can bend/fold. The point where your leg/hand or other body parts can bend, two or more bones are in contact. Such points are called as 'joints'.

State all the places where joints are present in your body.

______________________________

______________________________

______________________________

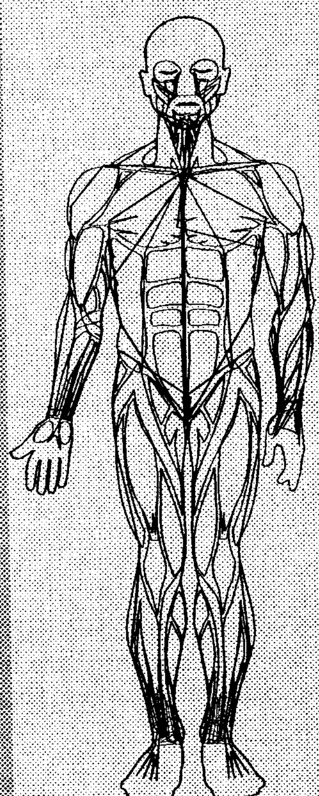
**Muscular system**

There are different kinds and shapes of muscles in our body.

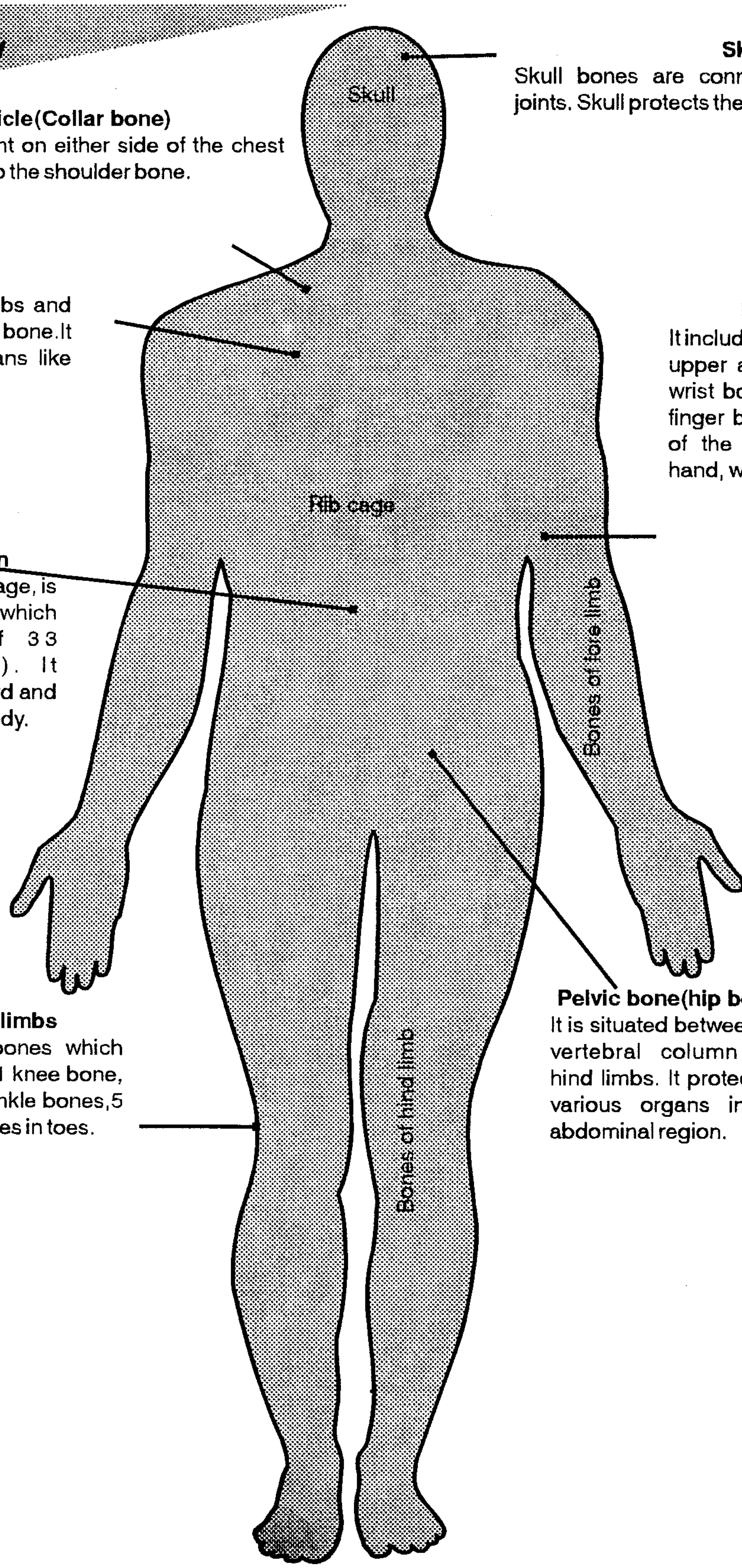
Muscles are made up of elastic and fibrous muscular tissue.

Muscles gives shape to the body.

Because of contraction and relaxation of the muscles we are able to move.



# Human body




**Clavicle(Collar bone)**
The bone present on either side of the chest and connects it to the shoulder bone.

**Skull**
Skull bones are connected **with immovable** joints. Skull protects the brain.

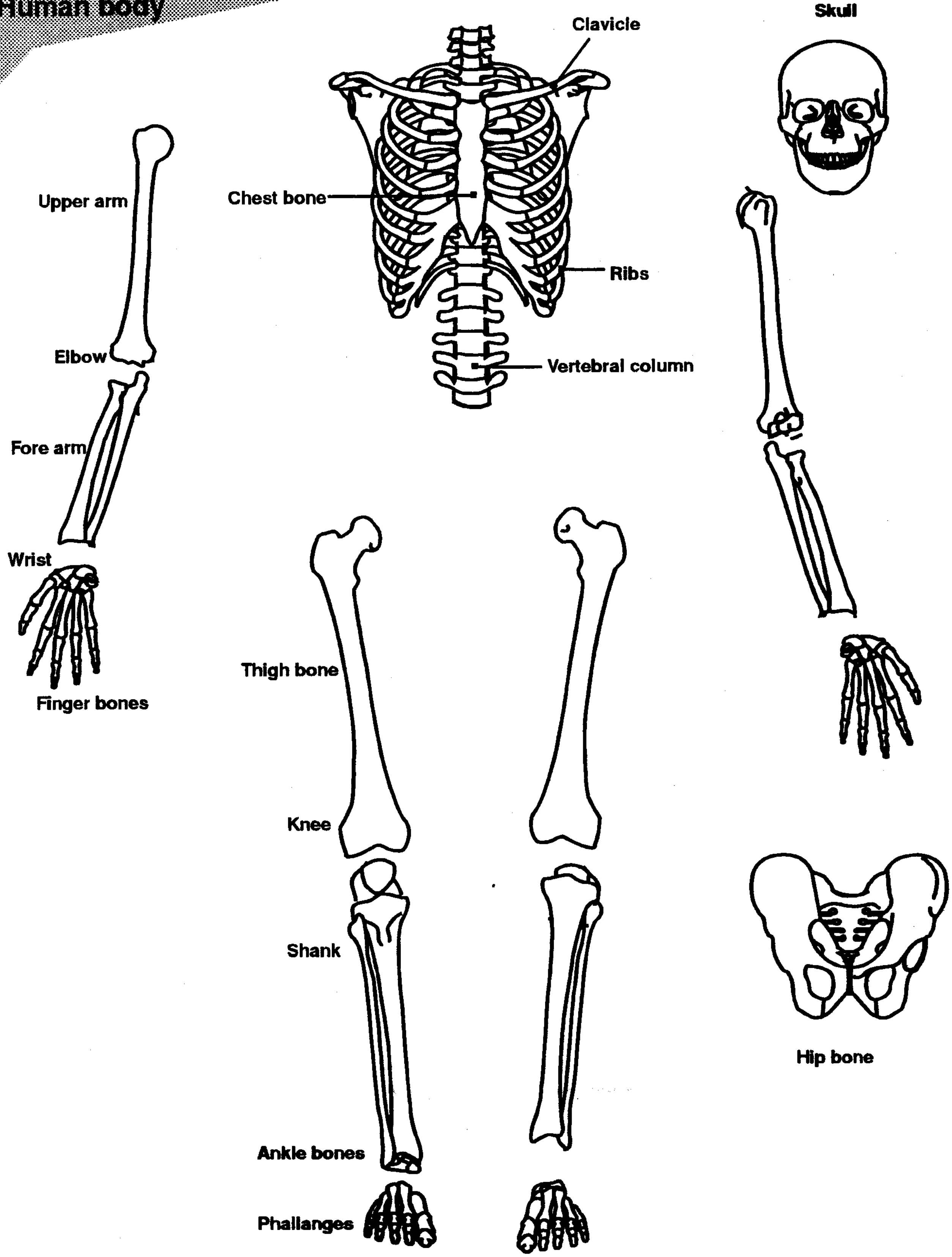
**Rib cage**
It is made up of 12 ribs and one long flat chest bone.It protects delicate organs like lungs and heart.

**Bones of fore limbs**
It includes 30 bones - 1 long bone of upper arm, 2 bones of fore arm,8 wrist bones, 5 palm bones and 14 finger bones(phallanges). Because of the movable joints present in hand, we are able to bend our hand.

**Vertebral column**
At the back of the rib cage, is the vertebral column which is made up of 33 bones(vertebrae). It protects the spinal cord and gives support to the body.

**Pelvic bone(hip bone)**
It is situated between the vertebral column and hind limbs. It protect the various organs in the abdominal region.

**Bones of hind limbs**
In all there are 30 bones which include 1 thigh bone, 1 knee bone, 2 bones of shank, 7 ankle bones,5 sole bones and 14 bones in toes.


Clavicle
Skull
Upper arm
Chest bone
Ribs
Elbow
Vertebral column
Fore arm
Wrist
Thigh bone
Finger bones
Knee
Shank
Hip bone
Ankle bones
Phallanges

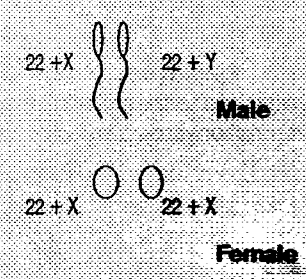
**Reproductive System**

Every generation of human beings continues by giving birth to young ones. The process of giving birth to young ones is known as reproduction (sexual reproduction).

Sexual reproduction involves the fusion of sperms (from male) and egg (from female) and results in the formation of a new organism which is different from the parent. The reproductive system in human male and female are distinctly different..

**What decides the new born baby is a boy or girl?**

It is decided by the genes (or the hereditary material which we get from our parents, also called DNA/genetic material) which are present on the chromosomes present in the cell. There are 46 chromosomes in cell normally written as'22pairs+XY or 22pairs +XX' which means that there are 44 chromosomes for normal functioning of cell and 'XY' or 'XX' is the chromosome pair which decides whether the child is boy or girl. When the new born has 22+XX configuration , then child is a girl and when it is 22+XY then the child is a boy. So it is the Y chromosome or the genes present on Y chromosome decides whether the newborn would be a baby boy or a baby girl.




**And some final body talk**

Ovary/Testis: Wait a minute, Aren't you people forgetting us? **Without us** new life would not have been formed. You all do your work within the **human** body but , we form the human body.

The continuity of life on the earth is maintained by the reproductive system.

Come, now let us study the reproductive system in human beings. On Page 122, you are given the pictures of male and female reproductive system. Study them well and answer the following questions. Name the different parts of the male reproductive system.

________________________________

________________________________

Name the different parts of the female reproductive system.

________________________________

________________________________

What is the function of the ovary and the testis?

________________________________

________________________________

State the function of the Vas deferens and the oviduct.

________________________________

________________________________

________________________________

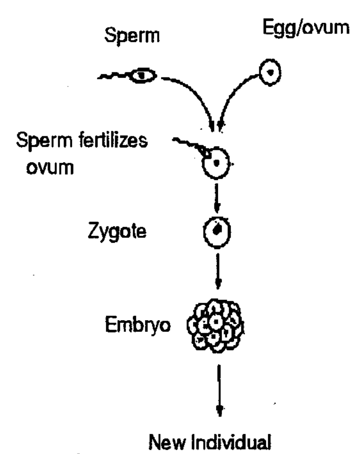
________________________________

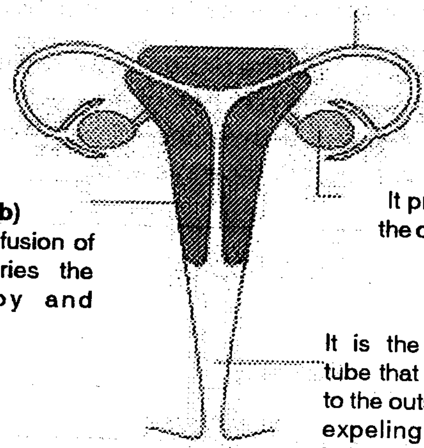
What is the function of the uterus?

________________________________

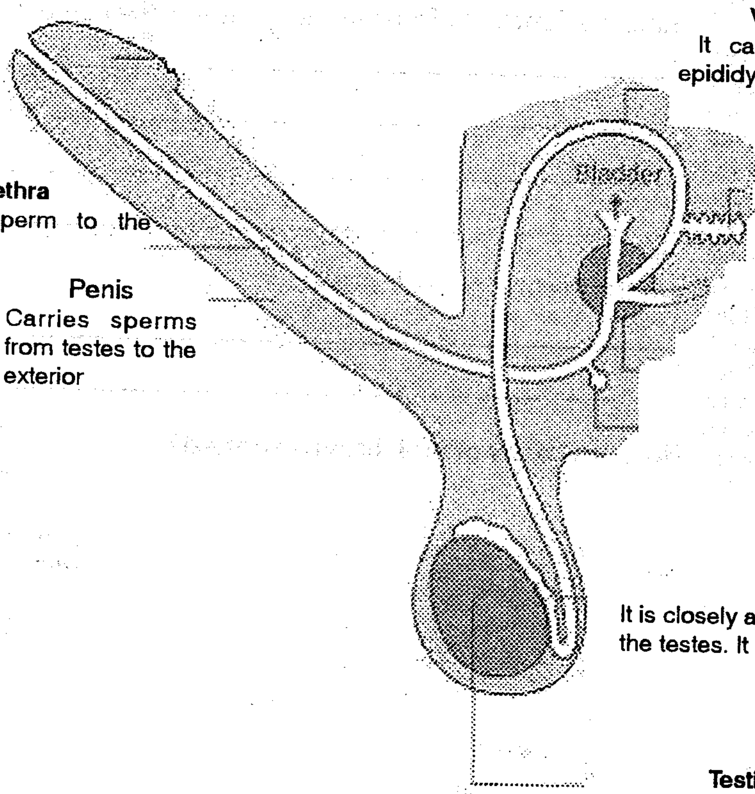
________________________________

**How new baby or individual is formed?**






**Female reproductive system**




**Male reproductive system**

# 15 Seeing Things in the Skies

**Things you Need**

**For Every Class**

Stick, Chart paper, White cloth, Balls of different size, Torch, Binoculars

**Note for the Teacher**

Organise night sky observations, Observations for the sundial should be taken every half an hour. Repeat 3/4 times.

**New Words**

Latitude
Longitude
Phases of moon
Eclipse

**Because the Earth is Round ...**

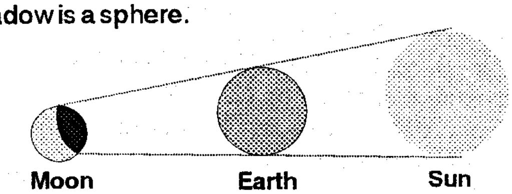
Did you know if you lie horizontally on a beach, and you just saw the Sun set, you can get up and see a second Sunset! Another result of the round Earth !!

Also how does one explain that the Sun is higher at noon in Bangalore than in Baroda? Yes, because the Earth is round!

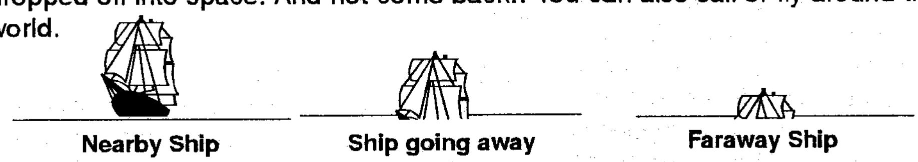
**Shape of the Earth**

Earlier people thought that our Earth is flat. But as time passed, people made observations that confirmed that the Earth is round. Some of these observations were:

1) At the time of total lunar eclipse, the full Moon slowly moves through Earth's shadow. Every time that shadow is seen, its edge is round. The only solid that always projects a round shadow is a sphere.




2) If you keep watching a ship on a sea going towards the horizon, the bottom part disappears but the upper part remains visible, finally even the upper part sinks in the horizon. Ships also comeback. If the Earth were flat, the ship should have dropped off into space! And not come back!! You can also sail or fly around the world.




3) If we travel on the Earth from North to South, the stars which are visible in the northern sky disappear even as many stars from the southern sky become visible to us.

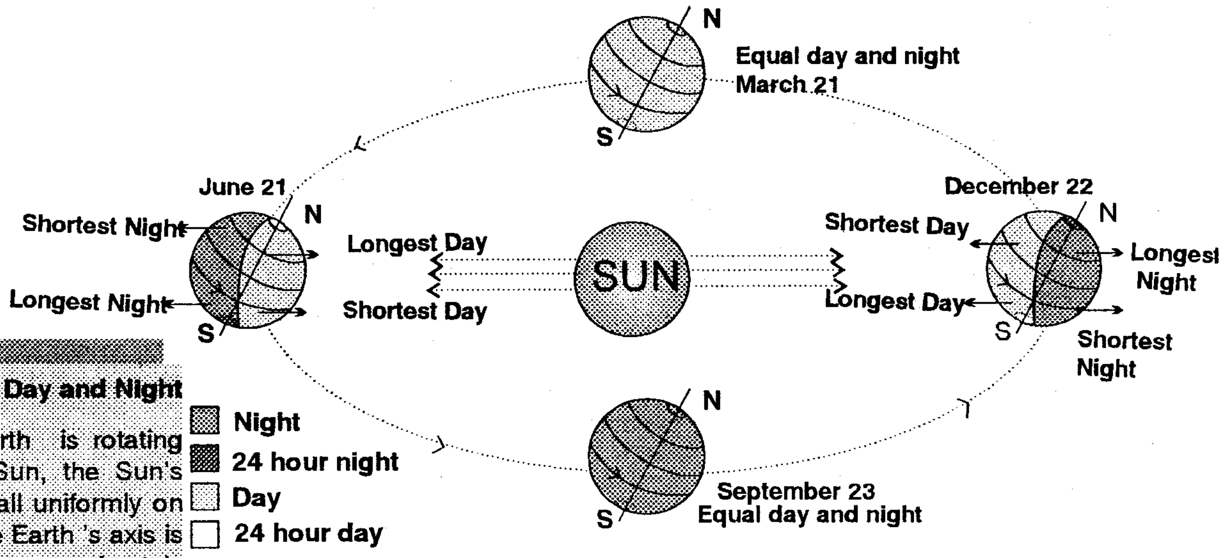
All these observations led to the belief that the Earth is round. Of course, the easiest way to prove that the Earth is spherical is to leave it and view it from a distance. Astronauts and space probes do that all the time. Every picture of Earth ever taken from space shows only a circular shape, and the only geometric solid which looks like a circle from any direction is a sphere.

**Earth's Motion**

We see from the our Earth the Sun, Moon and the stars revolving around Earth , rising from the east and setting in the west. From these observations, initially people were led to believe that the Earth is stationary and the Sun, Moon and stars are revolving around it. After further observations (over centuries) of the sky during day and night, astronomers realised that actually it is the Earth that is revolving on its axis from west to east as well as around the Sun. The phenomenon of day and night on Earth , rising of the Sun, Moon and stars in the east and setting in the west, etc., is a result of the Earth revolving on its own axis (like a top). The seasons, the yearly change in positions of all stars in the sky, etc., are the result of the spherical Earth's own motion around the Sun.

## Seeing Things

The stars and the constellations seen in the night change every month of the year. They are visible in the same order in every month every year. Similarly different seasons appear in the same order every year. All such observations indicate the fact that the Earth is revolving around the Sun.

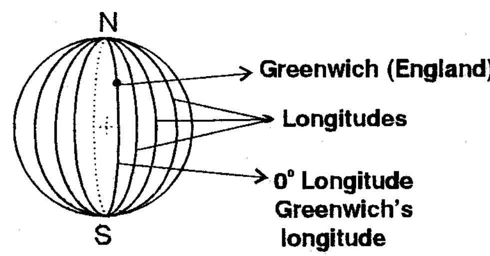


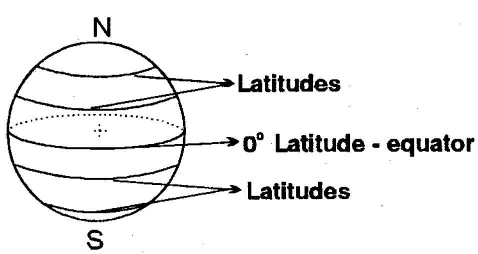

The Earth completes one circle around its axis in approximately 24 hours resulting in days and nights. How does this happen?

As shape of the Earth is almost round as shown in the picture, only about half the portion of the Earth receives Sunlight. There is a day on the half portion that receives Sunlight. The other half portion hidden away from the Sun is experiences night.

**Latitudes and Longitudes**

Our Earth is vast. Each and every point however can be given a unique "address" by specifying its latitude and longitude. Latitudes and longitudes are imaginary vertical and horizontal lines drawn on the Earth 's globe. These imaginary vertical and horizontal lines are shown in the picture below.




**The Longest Day and Night**

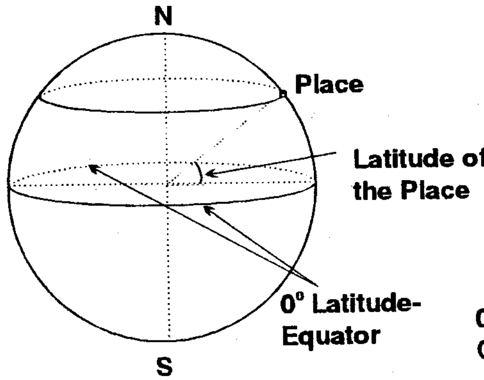
While the Earth is rotating around the Sun, the Sun's rays do not fall uniformly on Earth as the Earth 's axis is inclined at approximately 23.5 degrees.

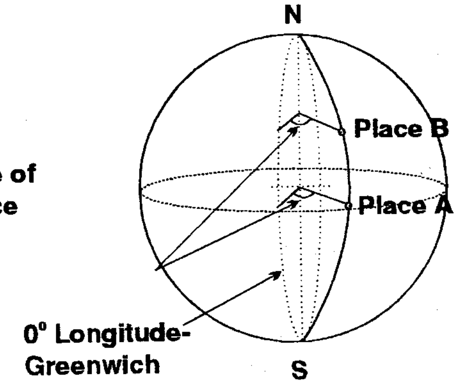
Look at the neighboring picture. On 21st June the Sun's rays fall straight and for longer time on the northern hemisphere. That is why there is longest day and a shortest night in the Northern half of the Earth. At the same time in the southern hemisphere the Sun's rays are inclined and fall for a short time. That is why there is a shortest day and a longest night in the Southern half.

For similar reasons, days are short and nights long in the Northern half around December 22nd.

On 21st March (spring equinox) and 23rd September (autumn equinox) -both the hemispheres receive equal Sunlight so the day and nights are equal. These are also the only days Sun rises exactly due east and sets exactly due west, taking 12 hours in between.

The parallel imaginary lines drawn from east to west on the **Earth 's globe are known as latitudes.** The vertical lines drawn from north pole to south pole on the Earth 's globe at distance of one degree are called longitudes. The length of all the longitudes is same.




**Longitude of the Place A and Place B is same.**

The latitude of any place tell us how far is that place from equator, due north or south. Similarly, the longitude of a place tells us whether the place is due east or west from the principle longitude or prime meridian. So if you can know the exact location of any place on the Earth 's surface, if you know both the latitude and the longitude of the place. The point where the latitude and the longitude intersect each other is the exact location of a place.

It takes 24 hours or one day for the Earth to rotate around its axis. In 24 hours, the Earth 's longitudes, from 0° to 360° also traverse around once in 24 hours as the Earth rotates. We can say therefore that the Earth rotates by 15° longitudes in one hour -- that means the Earth rotates by one degree longitude every 4 minutes. This results in a difference of 4 minutes in the time between the two neighbouring longitudes.

**The International Date Line**

Suppose it is noon where you are and you travel west -- and suppose you could travel instantly to wherever you wanted. Fifteen degrees longitude to the west the time is 11 a.m., 30 degrees to the west, 10 a.m., 45 degrees--9 a.m. and so on. Keeping this up, 180 degrees away one should reach midnight, and still further west, it is the previous day. This way, by the time we have covered 360 degrees and have come back to where we are, the time should be noon again--yesterday noon.

So have we travelled from today to the same time yesterday?

We have gotten into trouble because longitude determines only the hour of the day--not the date, which is determined separately. To avoid the sort of problem encountered above, the international date line has been established -- most of it following the 180th meridian--where by common agreement, whenever we cross it the date advances one day (going west) or goes back one day (going east). That line passes the Bering Strait between Alaska and Siberia, which thus have different dates, but for most of its course it runs in mid-ocean and does not inconvenience any local time keeping.

Now we shall try to explore more about some celestial events. We shall sometimes use the information related to Earth while doing this. We see everyday the Sun, the Moon and the stars in the sky. Our ancestors studied the constantly changing places of the Sun, Moon and stars to understand the changing natural phenomena. We will try and do the same in a small way. We shall have to observe the sky for many days to do so.

**6 months night and 6 months day**

As the Earth is inclined on its axis both it's poles and the area around the poles receives Sunlight for continuous six months alternatively. Because of this the polar regions have 6 months day and 6 months night.

When 6 month day is on the north pole, then there is 6 month night on the south pole. Similarly, when 6 month day is on the south pole, then there is 6 month night on the north pole.

The days and nights are of equal time on the equator throughout the year. On other places on the Earth, 23rd September and 21st March have equal day and night as the Sun's rays fall straight on the Earth.

On the equinoxes - one should add - that the days are 12 hours except at the poles. At the poles the Sun appears to graze the horizon -that is it will appear to go around a circle. On March 21st, at the North Pole, the Sun is rising for the six month polar r day and the at the South Pole the Sun is preparing to set for the six-month long polar night. On September 23rd, it will be the other way around!!

### Experiment 1: Rising and Setting Time of the Sun

Note down the exact time of Sunrise and Sunset. Use any single accurate clock for this purpose on all the days. Write down your observations in the given table:

**Table 1**

| Date | Sunrise Time | Sunset Time | Time between Sunrise & Sunset |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

Parul has noted her observations in the table below. You may use them if you want.

| | | | |
|---|---|---|---|
| 1 | 5.39 | 6.11 | |
| 2 | 5.47 | 6.21 | |
| 3 | 5.53 | 6.32 | |

Based on your observations say whether time of the Sunrise remains same everyday?

______________________________

Does the time of Sunset remains same or changes everyday?

______________________________

Does the time span between Sunrise and Sunset remains the same or changes?

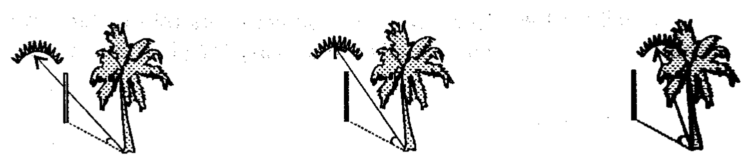
______________________________

You can find out more about the changes in the length of the days and nights from the difference in the time of Sunrise and Sunset.

You have observed that the time of Sunrise and Sunset changes. To find out whether the place of Sunrise also changes let us perform the next experiment.

### Experiment 2: Place of Sunrise and Sunset

Make a mark near any tree or pole. Stand on this mark everyday and watch the Sunrise and the Sunset twice or thrice a week. Make your observations for about a month in the same way.



**The Biggest Latitude**

We know that the northern end of the Earth's axis is called north pole and southern end is called south pole. In between north and south poles, there an imaginary horizontal line which is called equator. The equator divides the Earth's globe into two equal parts. The northern part is called northen hemisphere and the southern part is called the southern hemisphere.

This way a latitude of the place shows its angular distance towards north or south from the equator. Equator is the biggest latitude. Any place on the equator makes a 0 degree angle with the **Earth**'s center. So what will be the latitude of that place? What is the latitude of the North Pole?

****

The Pole star (dhruva) is exactly above the North Pole. That is if you stand on the North Pole on a clear night, the Pole Star will shine over your head. If you come down 70 degrees south from the North Pole, that is your latitude is 30 degrees, where would you see the Pole Star in the night sky? Where would you see the Pole Star, if you were on the equator?

Does the Sun rise in the same place every day? Or does it **keep changing its** place? How does the Sun appear to move?

___

When Sun moves towards south in the sky then it is called dakshinayan and when the Sun moves towards north in the sky it is called uttarayan. From your observations can you say whether the Sun is in dakshinayan or uttarayan?

___

In India and countries north of the equator, the Sun's daily trip (as it appears to us) is an arc across the southern sky. (Of course, it's really the Earth that does the moving.) The Sun's greatest height above the horizon occurs at noon, and how high the Sun then gets depends on the season of the year--it is highest in mid-summer, lowest in mid-winter.

Boy scouts used to be taught that someone lost in the woods can often tell the north direction by checking on which side of tree-trunks lichens grew best. Lichens avoid direct Sunlight, and with the Sun's path curving across the southern sky, the north side of a tree-trunk is the one most shaded.

For a similar reason--but to collect Sunlight rather than avoid it--solar collectors for heating water or generating electricity always face south. In addition, they are invariably tilted at an angle around 45°, to make sure that the arrival of the Sun's rays is as close to perpendicular as possible. The collector is then exposed to the highest concentration of Sunlight.

We know that the Sun rises in the east and sets in the west. Sun moves from east to west from the time of Sunrise to Sunset. Can you tell from this in which direction does the Earth moves on its axis? East to West? Or the other way?

___

Where does the Sun rise early in India? In Kolkata or Vadodara?

___

Where does the Sun set early in India? In Kolkata or Vadodara?

___

It has been observed that the Sun moves towards north as well as towards south. From Sunrise to Sunset Sun moves towards west from east. Our ancestors used both these movements of the Sun to know the time. We will try and understand more about this in the next experiment.

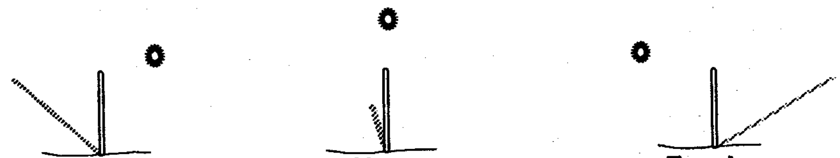
**Experiment 3: Sundial from a Stick -1**

Perform this experiment on a clear day from 9.00 am to 4.00 pm. Take approximately one meter long stick. Select an open space that is in Sunlight for the entire day. Position the stick in the ground perpendicular to the ground surface. Make a mark on the shadow of the stick at 9.00 am. Mark the shadow after every half an hour. Note the length of the shadow in the table given below.

**Table 2**

| Time | Length of Shadow | Time | Length of Shadow |
|---|---|---|---|
| 9.00 | | 11.30 | |
| 9.30 | | 11.45 | |
| 10.00 | | 12.00 | |
| 10.30 | | 12.15 | |
| 11.00 | | 12.30 | |

| Time | Length of Shadow | Time | Length of Shadow |
|---|---|---|---|
| 12.45 | | 2.30 | |
| 1.00 | | 3.00 | |
| 1.15 | | 3.30 | |
| 1.30 | | 4.00 | |
| 2.00 | | 4.30 | |




Does the shadow changes it's place? Say from your observations.

Explain the reason for this change in place of shadow.

When is the Sun's light maximum and most intense? What is the position of the Sun at that time in the sky?

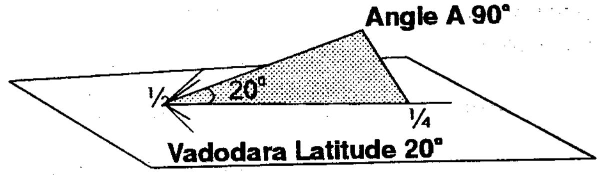
Is the shadow at that time long or short?

The shortest shadow during the day at any time of the year indicates north-south direction. Exactly perpendicular to this shadow is the east-west direction.

How is the intensity of the Sunlight when the shadow is longer? More or less?

**Experiment 4: Sundial -2**

Make a right angle triangle from a cardboard ABC to make this type of Sundial. The angle ACB should be same as the latitude of the place where you are. Angle BAC is 90 degrees. Hypothenuse AC should be parallel to the latitude of our city.




Fix this triangle on the center of a wooden **board or cardboard** base perpendicularly.

**The *Aryabhatiya***

That the Earth revolves around its own axis is recorded by Aryabhata, the great Indian astronomer (born 476 AD), in his *Aryabhatiya:*

Just as a passenger in a boat moving downstream sees th stationary (trees on the river banks) as traversing upstream, just so does an observer at Lanka see the fixed stars as moving towards the west at exactly the same speed (at which the Earth moves from west to east.)

XXX

The Earth revolves around its axis from east to west. So the places from the east come in front of the Sun earlier, and the places on the west side come later in front of the Sun. Hence the clock time in the places in the east is ahead than the places in the west. The places on different longitudes present themselves before the Sun at different times. They have different clock time. Whereas the places on the same longitude present themselves in front of the Sun at the same time. So they have same clock time.

What will happen if our Earth starts revolving round the Sun from west to east?

Make the triangle stand with help of the paper stickers fixed on side BC on the base as shown in the picture.

Now place this Sundial on the plane ground where you get maximum Sunlight. Place the base of the triangle BC facing north south direction. Always remember to place point B of the triangle towards north direction. Make a line where you get the shadow of the Gammon AC of the triangle at 9.00 am. Mark the shadows of the gammon AC after every half an hour. With every line of the shadow write down the corresponding time in the table 3. You will be able to find the time looking at the shadow.

**Table 3**

| Time | Length of Shadow | Time | Length of Shadow |
|---|---|---|---|
| 9.00 | | 12.45 | |
| 9.30 | | 1.00 | |
| 10.00 | | 1.15 | |
| 10.30 | | 1.30 | |
| 11.00 | | 2.00 | |
| 11.30 | | 2.30 | |
| 11.45 | | 3.00 | |
| 12.00 | | 3.30 | |
| 12.15 | | 4.00 | |
| 12.30 | | 4.30 | |

Repeat the observations afer a week and a fortnight. Does the shadow of the stick fall on the same place even now? Does it have any relation with the changing place of the Sun? Explain on the basis of experiment 1, 2, 3 and 4.

______________________________

______________________________

We see the Moon in the sky every night. We get to see the Moon changing it's phases. The changing shape of the Moon is known as phases of the Moon. Let us do the next experiment to understand the phases of the Moon.

**Experiment 5: Phases of the Moon -1**

Select a day, 5 to 6 days after a Moonless night (amavasya), when we can see the Moon in the sky during the daytime. Stand in the Sunlight. Hold a lemon or a ball in hand in the direction of the Moon.

**Indian Standard Time**

Is calculated at the Allahabad observatory. Allahabad is 82.5 °E of the Prime Meridian and as a result the time difference between Greenwich and Allahabad is exactly 5 hours and 30 minutes.

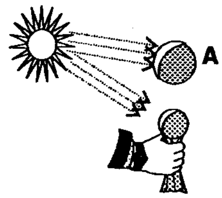
The entire country shares the same time zone. As result Sunrise and Sunset times are substantially different across the breadth of the country.

India's time zones were established in 1884, when there were two standard time zones, Bombay Time and Calcutta Time. The IST came into effect in 1905. However, Bombay still persisted with its own time zone, 39 minutes behind IST, until 1955.

The latitudes of some places in Gujarat are given below:

| No. | District | Latitude |
|---|---|---|
| 1. | Vadodara | 22° |
| 2. | Valsad | 20° |
| 3. | Ahmedabad | 23° |
| 4. | Surat | 21° |

The Sun rises at 5.30 am on a certain day at Kolkata. Will it be dark or Sunrise at Baroda at the same time (IST)?




**What if the Earth's axis were not tilted at all?**

First of all, the Pole Star would not be Polar.

The earth would face the Sun's rays from the same angle and we would have one and the same season throughout the year.

We can call this season winter, spring or summer depending on our location. Everywhere and always day would be equal night.

However near the Poles, day or early morning would be perpetual and sun would not set but go around the horizon in a circle once in 24 hours. The Polar region would not be therefore as cold as it is now.

A place like Baroda would have tolerable climate. Whereas nearer as we go north, the climate would be milder and milder.

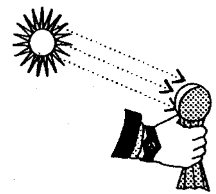
**Add a Kilometer**

The earth's orbit is almost a circle (actually it is an ellipse) with the average distance from the Sun being about 150 million km. If we added one kilometre to this distance, how much longer would be an year assuming no change in earth's speed around the Sun?

Find out on which part of the ball or lemon does sunlight fall directly? Is shape of the lighted portion of the ball and the Moon same?

We will perform one more experiment to understand this concept.

**Experiment 6: Phases of the Moon -2**



Wrap a ball with white cloth. This is a model of the Moon. Hold this model in sunlight parallel to the hand. Now you turn around slowly. The portion of the ball which receives sunlight changes its shape.

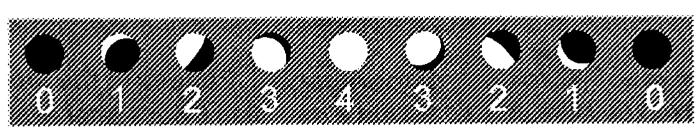
Does half the portion of the ball always is in sunlight?

How is the shape of the lighted portion every time? Same or different?

On basis of this experiment write down the reason of the Moon's phases in your own words.

We found out the reason behind the Moon's phases. Now let us try to understand the regularity in the time of these phases occur.

**Experiment 7: Observation of the Moon**

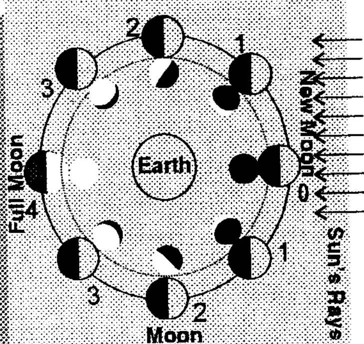



From the no Moon tight till full Moon night note down the Moon's rising and setting time and date in Table 4. Also draw the phase of the Moon on that day. Similarly, write down your observations from full Moon night to no Moon night.

Table 4

| Date after the No Moon Night | Time of Moonrise | Phase of the Moon | Time of Moon's Setting | Date after the Full Moon Night | Phase of the Moon |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Phases of the Moon




One of the important causes of tides is the pull of the moon and sun on earth's ocean. The moon's attraction is stronger for points on the earth that is nearer the moon than that is diametrically opposite. It is this difference that causes water to rise in both cases above the surface of the Earth. In the first case water moves towards the Moon more than the solid part of the Earth. In the second case, the Earth's solid part moves more towards the moon than the water.

The Sun's pull on the Earth has similar effects on the Earth's oceans. But because the Sun is much farther than the Moon, the Sun contributes only 40 % to the height of the tides as compared to the Moon.

We learnt some things about the Sun and the Moon. Now we will study about the solar system, solar eclipse and the lunar eclipse.

**The Solar System**

You are given a diagram of solar system on page number ---. Different planets from the solar system are shown with some information about them. You are given the locations of of different planets on the same page. You have to place different planets according to their position in the solar system. Look into the information of all the planets after arranging them in order. On the basis of the information given answer the following questions.

How far is the Earth from the Sun?

_______________

Which planet takes 88 days to revolve around the Sun?

_______________

How many Moons does the Earth have?

_______________

Which is the biggest planet of the solar system?

Which is the smallest planet of the solar system?

Which planet of the solar system is nearer to the Sun?

Which planet of the solar system is farthest to the Sun?

Which two planets of the solar system are visible in the morning and the evening?

Which planet comes after the Earth in the solar system?

Between which two planets you see the band of small planet like bodies?

Which planet has maximum number of satellites?

Which planet of the solar system has rings?

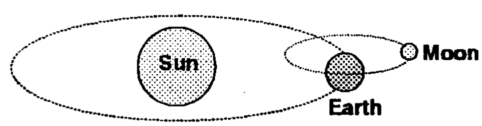
Apart from planets, satellites and bands of small planets which other things are included in the solar system?

The distance between the Sun and the Earth is approximately 15 crore kilometers. Then how much time will it take for a Sun's ray to travel down to Earth ? (The speed of light is 3 lakhs km per second.)

We gathered information about the solar system. Now we will try to understand the solar and lunar eclipse by performing some experiments.

**Experiment 8: Eclipse**

Now we know that the Sun is in the center of the solar system and the planets are revolving around it. The satellite of the Earth, Moon, revolves around the Earth. . This celestial phenomenon is described in the picture below.




We have learned in Class 5 that the Sun is self luminous, whereas the Earth (planet) and the Moon (satellite) are non-luminous or reflecting bodies, i.e., they are visible only when Sunlight falls on them.

**Solar System**

The Sun, planets, satellites, small planets, meteorites, comets, all together form the solar system.

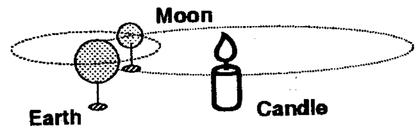
**Small planets:** Between Mars and Jupiter there is a band of small planets. These small planets also revolve around the Sun.

**Meteorites:** We know meteorites as shooting stars. The shiny lines which we observe in the sky during night, are celestial tiny objects. These celestial bodies are also attracted to the Earth by gravitation. When they come in contact with the atmosphere of the Earth , they start burning due to the friction and appear like shining moving lines in the sky.

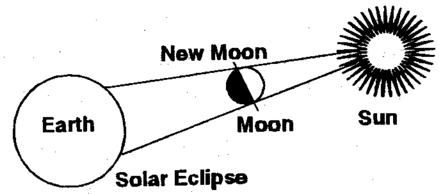
**Why do we see stars only during night?**

The Sun is very near to the Earth, we receive a lot of light. During the day the Sun's brightness does not allow us to see the other stars in the sky. In the night when the Sun is not visible, we can see the light of the other stars in the sky

Collect the things as shown in the picture below: Arrange them in the appropriate place.




If we consider the small ball as Moon, then revolve it around the bigger ball which is Earth slowly. Simultaneously, revolve the bigger ball i.e., Earth around the Sun (biggest ball or electric bulb). Observe and answer the following questions.




Does the Moon ever come between the Earth and the Sun?

______________________________

Whose shadow fall son Earth at that time?

______________________________

Does the Earth ever gets covered totally with the shadow? Or how much portion of the Earth is covered with the shadow of the Moon ?

______________________________

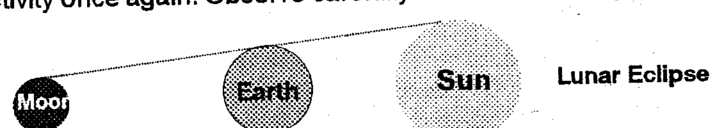
Can we see the whole of the Sun from within the region of the Moon's shadow? Why?

______________________________

______________________________

When the Moon comes between the Earth and the Sun, then the shadow of the Moon falls on the Earth . Because of this the people in the region of this shadow are not able to see the Sun fully or partly. We call this phenomenon as the solar eclipse.

Repeat the activity once again. Observe carefully and answer the questions given below.




Does the Earth ever come between the Moon and the Sun?

______________________________

Whose shadow fall s on Moon at that time?

______________________________

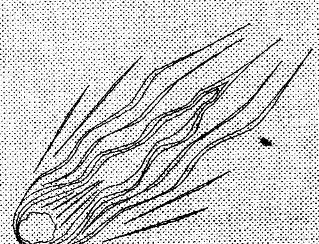
Does the Moon gets covered totally with the shadow?

______________________________

### Comet

We know the comet as a star with a tail. A comet is not a star in reality. It does not have a tail also. As the comet moves nearer the Sun, its tail appears to grow in the opposite direction. Similarly, as it goes away from the Sun, its tail becomes shorter.

A comet is a ball of gases and celestial dust particles and is covered with ice. On the outer zone of the solar system, beyond Pluto there are billions of comets. This colony of comets is known as Urt's colony of comets.

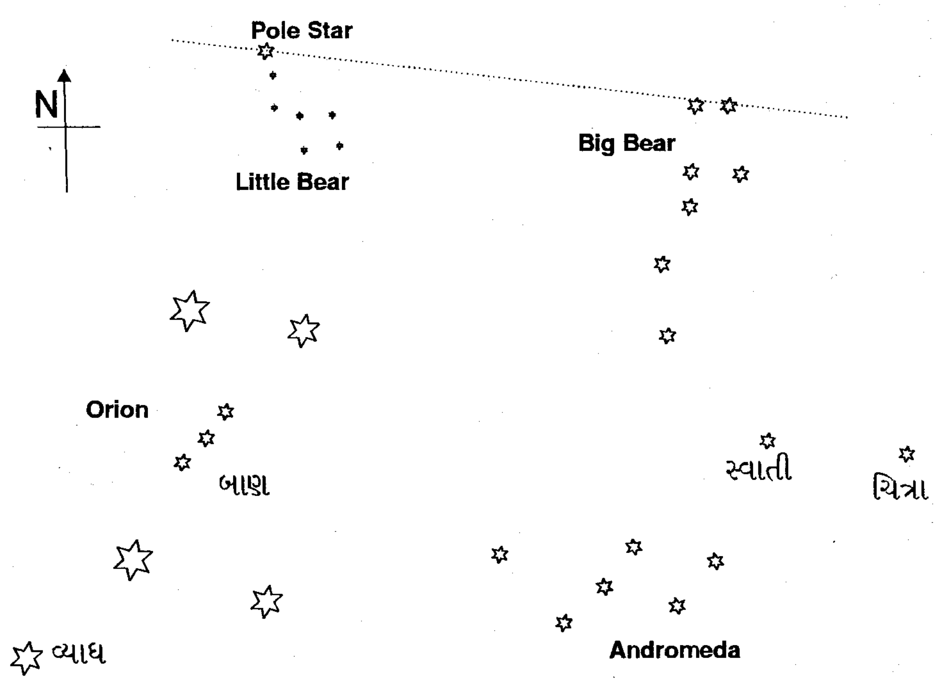


Can we see the whole of the Moon from the Earth during this event? Why?

When the Earth comes between the Moon and the Sun then the shadow of the Earth falls on the Moon. Because of this the people on the Earth are not able to see the shadow covered region of the Moon. We call this phenomenon as the lunar eclipse.
After studying Sun and the Moon let us find something about the stars.

**Experiment 9: Constellations**
You are shown a picture of various constellations. Look carefully at the stars and constellations one by one with the help of the picture. Try to identify them in the sky during night. You will enjoy to observing constellations like the big bear, andromeda, lion, scorpion etc. So, happy star gazing!

Find the English names of some of the Gujarati equivalents given below. And also the Gujarati names of the English ones.




**What are Stars?**

Stars are like the Sun but only much more massive and very far. The Sun is a star. How far are the stars?

The nearest stellar (adjective of star) neighbors to the Sun are three stars that make up a multiple system. To the naked eye the system appears as a single bright star, Alpha Centauri. Alpha Centauri is a double star – two stars revolving about each other that are too close to be seen as separate by the naked eye. Near them is the third member of the system, a faint star known as Proxima Centauri. Discovered in 1915, it is smaller than Alpha and Beta. Proxima (meaning nearest) it is slightly nearer to the Sun than the other stars in this triple star system.

Light travels at 300,000 km per second. Light from the Sun takes 8 minutes to reach the Earth. The star nearest to the Sun is Proxima Centauri. If we travel at the speed of light, at least in our imagination, it would take 4.3 years to reach Proxima Centauri from Earth.

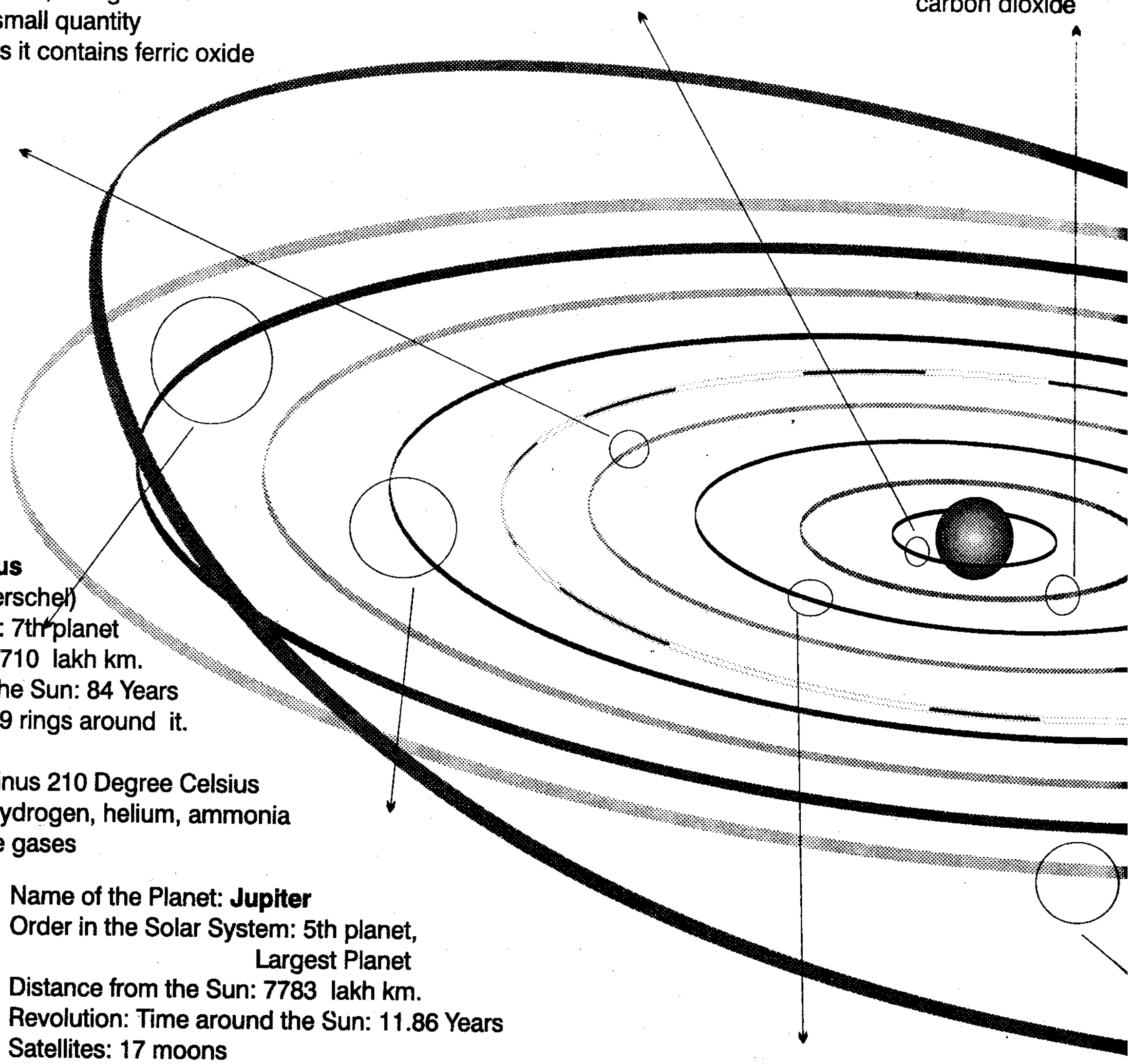
**Light Year**

Astronomers measure the distance between stars in units called light-years. A light-year equals 10 trillion kilometers. This is the distance light travels in one year at the speed of 300,000 km per second. Proxima Centauri is 4.3 light-years from the Sun, that is a distance of over 40 trillion km, some 270,000 times greater than the distance between the earth and the sun.

Name of the Planet: **Mars**
Order in the Solar System: 4th planet
Distance from the Sun: 2280 lakh km
Revolution Time around the Sun: 687 Days
Satellites: 2- Phobos and Demos
Planet's Day: 25 Hours
Temperature: Day time: Minus 20 Degree Celsius
Atmosphere: Carbon dioxide, nitrogen and oxygen in small quantity
Mars shows red colour as it contains ferric oxide

Name of the Planet: **Mercury**
Order in the Solar System: 1st planet, Smallest
Distance from the Sun: 579 lakh km.
Revolution Time around the Sun: 88 Days
Satellites: No satellites
Planet's Day: 1400 Hours
Temperature: Day time: 430 Degree Celsius
Atmosphere: Helium gas

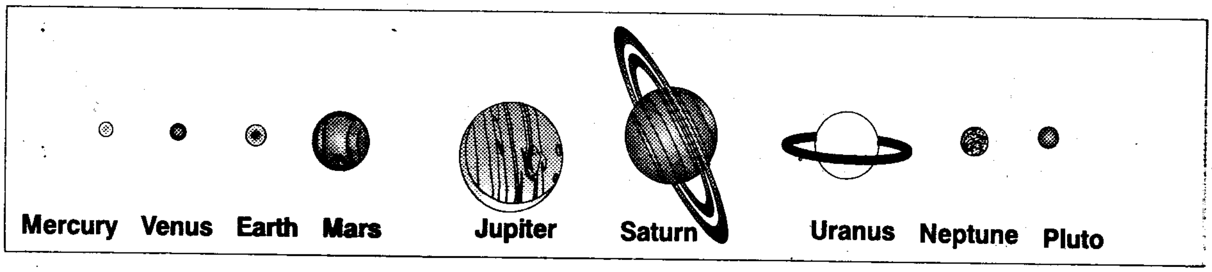
Name of the Planet
Order in the Solar S
Distance from the S
Revolution Time arc
Satellites: No **satelli**
Temperature: **Day ti**
Planet's Day: **5800 I**
Atmosphere: **Made**
carbon dioxide



Name of the Planet: **Uranus**
(Discovered by William Herschel)
Order in the Solar System: 7th planet
Distance from the Sun: 28710 lakh km.
Revolution: Time around the Sun: 84 Years
Satellites: 15 moons, Has 9 rings around it.
Planet's Day: 17 Hours
Temperature: Day time: Minus 210 Degree Celsius
Atmosphere: Made from hydrogen, helium, ammonia and methane gases

Name of the Planet: **Jupiter**
Order in the Solar System: 5th planet, Largest Planet
Distance from the Sun: 7783 lakh km.
Revolution: Time around the Sun: 11.86 Years
Satellites: 17 moons
Planet's Day: 10 Hours
Temperature: Day time: Minus150 Degree Celsius
Atmosphere: Made from hydrogen, helium gases

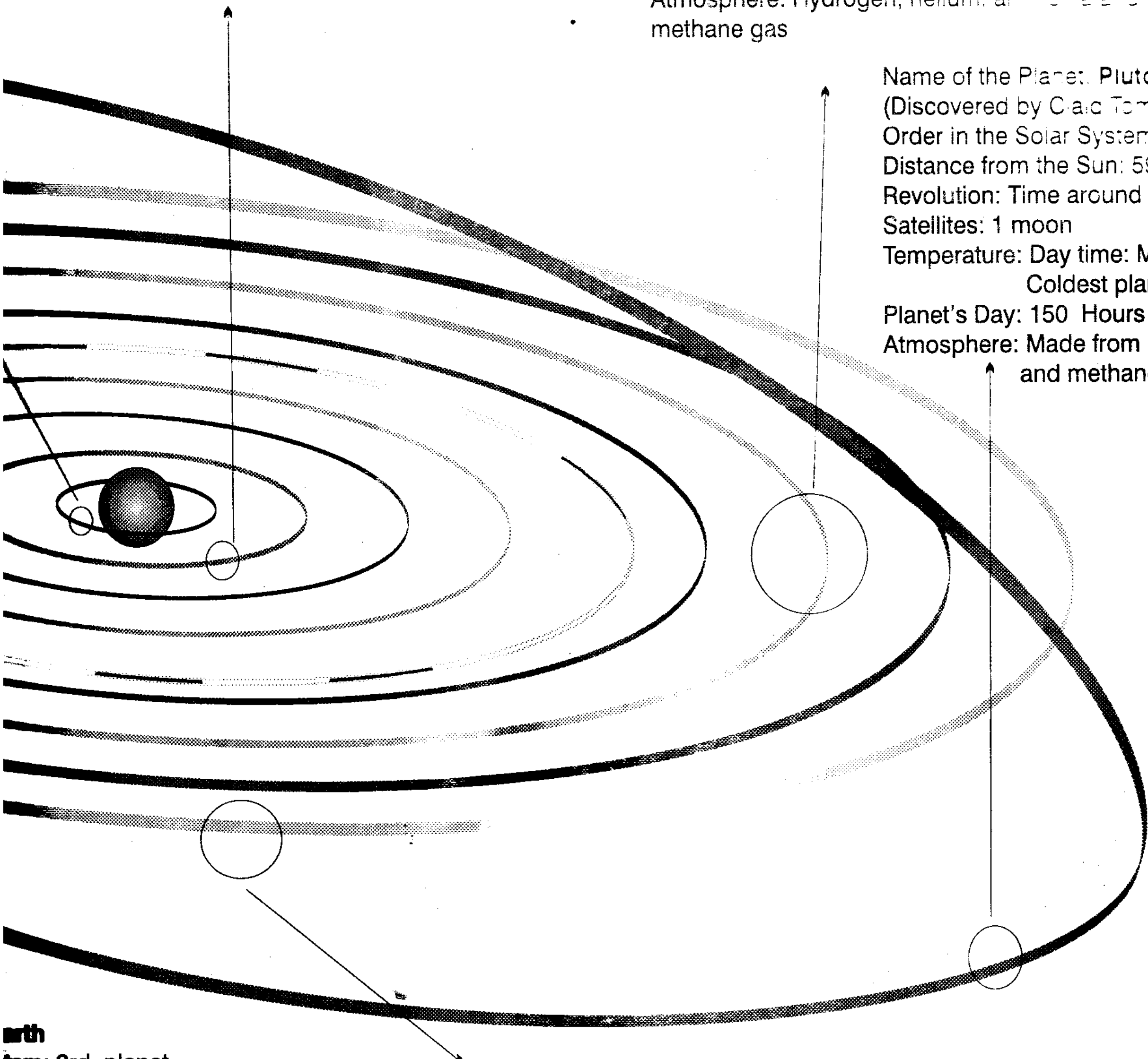
Name of the Planet: **Earth**
Order in the Solar System: 3rd planet
Distance from the Sun: 1497 lakh km.
Revolution: Time around the Sun: 365 Days
Satellites: 1 moon
Planet's Day: 24 Hours
Atmosphere: Made from different gases and moisture
It is the only planet on which life is found.



Name of the Planet: **Venus**
Order in the Solar System: 2nd planet, Brightest
Distance from the Sun: 1085 lakh km.
Revolution Time around the Sun: 225 Days
Satellites: No satellites present
Temperature: Day time: 470 Degree Celsius
Planet's Day: 5800 Hours
Atmosphere: Made of clouds of
carbon dioxide

Name of the Planet: **Saturn**
Order in the Solar System: 6th planet
Distance from the Sun: 14270 lakh km
Revolution: Time around the Sun: 30 years
Satellites: 24 moons. Saturn has 12 rings around it
Temperature: Day time: Minus 180 Degree Celsius
Planet's Day: 10 Hours
Atmosphere: Hydrogen, helium, ammonia and
methane gas

Name of the Planet: **Pluto**
(Discovered by C[illegible] To[illegible])
Order in the Solar System: 9th planet
Distance from the Sun: 59135 lakh km.
Revolution: Time around the Sun: 247.7 years
Satellites: 1 moon
Temperature: Day time: Minus 250 Degree Celsius
Coldest planet
Planet's Day: 150 Hours
Atmosphere: Made from hydrogen, helium
and methane gases

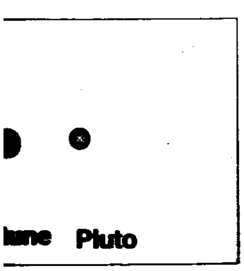


**rth**
**tem**: 3rd planet
**: 1497** lakh km.
**nd** the Sun: 365 Days

**s**
**m different gases**

**which life is found.**

Name of the Planet: **Neptune**
(Discovered by Louverier, Adams and Galeny)
Order in the Solar System: 8th planet
Distance from the Sun: 44966 lakh km.
Revolution: Time around the Sun: 164.8 Years
Satellites: 8 moons
Planet's Day: 16 Hours
Temperature: Day time: Minus 220 Degree Celsius
Atmosphere: Made from hydrogen, helium
and methane gases



# The Periodic Table

Metals

Non-Metals

Symbol
At.mass
At. Number

Transition Metals

| 1 Alkali Metals | 2 Alkali earth metals | | | | | | | | | | | 3 Borons and Carbons | 4 | 5 Nitrogens and Oxygens | 6 | 7 Halogens | 8 Inert gases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H 1 1 Hydrogen | | | | | | | | | | | | | | | | | He 4 2 Helium |
| Li 7 3 Lithium | Be 9 4 Berelium | | | | | | | | | | | B 11 5 Boron | C 12 6 Carbon | N 14 7 Nitrogen | O 16 8 Oxygen | F 19 9 Fluorine | Ne 20 10 Neon |
| Na 23 11 Sodium | Mg 24 12 Magnesium | | | | | | | | | | | Al 27 13 Aluminum | Si 28 14 Silicon | P 31 15 Phosphorus | S 32 16 Sulphur | Cl 35 17 Chlorine | Ar 40 18 Argon |
| K 39 19 Potassium | Ca 40 20 Calcium | Sc 45 21 Scandium | Ti 48 22 Titanium | V 51 23 Vandanium | Cr 52 24 Chromium | Mn 55 25 Manganese | Fe 56 26 Ironn | Co 59 27 Cobalt | Ni 59 28 Nickel | Cu 64 29 Copper | Zn 65 30 Zinc | Ga 70 31 Gallium | Ge 73 32 Germanium | As 35 33 Arsenic | Se 79 34 Selenium | Br 80 35 Bromine | Kr 84 36 Krypton |
| Rb 85 37 Rubidium | Sr 88 38 Strauncium | Y 89 39 Yttrium | Zr 91 40 Zirconium | Nb 93 41 Niobium | Mo 96 42 Molybdenum | Tc 97 43 Technetium | Ru 101 44 Ruthenium | Rh 103 45 Rhodium | Pd 106 46 Palladium | Ag 108 47 Silver | Cd 112 48 Cadmium | In 115 49 Indium | Sn 119 50 Tin | Sb 122 51 Antimony | Te 128 52 Tellurium | I 127 53 Iodine | Xe 131 54 Xenon |
| Cs 133 55 Cesium | Ba 137 56 Barium | La 139 57 Lanthanum | Hf 178 72 Hafnium | Ta 181 73 Tantalum | W 184 74 Tungstun | Re 186 75 Rhenium | Os 190 76 Osmium | Ir 192 77 Iridium | Pt 195 78 Platinum | Au 197 79 Gold | Hg 201 80 Mercury | Tl 204 81 Thallium | Pb 207 82 Lead | Bi 209 83 Bismuth | Po 209 84 Polonium | At 210 85 Astatine | Rn 222 86 Radon |
| Fr 223 87 Francium | Ra 226 88 Radium | Ac 227 89 Actinium | Rf 260 104 Rutherfordium | Ha 105 Hahnium | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ce 58 Cerium | Pr 59 Praseodymium | Nd 60 Neodymium | Pm 61 Promethium | Sm 62 Samarium | Eu 63 Europium | Gd 64 Gadolinium | Tb 65 Terbium | Dy 66 Dysprosium | Ho 67 Holmium | Er 68 Erbium | Tm 69 Thulium | Yb 70 Ytterbium | Lu 71 Lutetium |
| Th 90 Thirium | Pa 91 Protactinum | U 92 Uranium | Np 93 Neptunium | Pu 94 Plutonium | Am 95 Americium | Cm 96 Curium | Bk 97 Bakelite | Cf 98 Californium | Es 99 Einsteinium | Fm 100 Fermium | Md 101 Mendelevium | No 102 Nobelium | Lr 103 Lawrencium |

# The Periodic Table...

In1869, Mendeleev was among th first to try and organise elements in some order-called a periodic table. Elements are arranged in order of increasing atomic numbers.

he vertical columns in the table are called groups. All the elements in the group behave similarly in a chemical reaction.
Most metals have only one electron in their last orbit and are highly reactive. They are ready to donate the electron.
Most non-metals have incomplete orbits so they are ready to accept electrons. The elements in the last group have complete orbits, therefore they are unreactive. They are called Inert Gases. Elements beyond atomic number 92 (Uranium) are not naturally occurring and are made in the lab.

***Some useful definitions-***

*Atomic Number: Number of protons in the nucleus of the atom.*
*Atomic mass: Number of protons and neutrons in the nucleus of the atom.*

***Activity:***

Colour the metals, non metals, transition metals, metalloids and noble gases in different colours in the neighboring periodic table. The dark lines separate them.

- [ ] **Metalloids have some properties of metals and some of non-metals.**
- [ ] **Non-Metals are ready to accept electrons**
- [ ] **Metals are highly reactive**
- [ ] **Noble gases**

| | | | | |
|---|---|---|---|---|
| $Na^{+1}$ **Sodium** | $K^{+1}$ **Potassium** | $NH_4^{+1}$ **Ammonium** | $Fe^{+2}$ **Ferrous** | $Li^{+1}$ **Lithium** |
| $Mg^{+2}$ **Magnesium** | $Zn^{+2}$ **Zinc** | $Cu^{+2}$ **Copper** | $H^{+1}$ **Hydrogen** (Read as Hydrochloric acid with chloride, Nitric acid with Nitrate, Carbonic acid with Carbonate) | $Ca^{+2}$ **Calcium** |
| $Na^{+1}$ **Sodium** | $K^{+1}$ **Potassium** | $K^{+1}$ **Potassium** | $H_2^{+2}$ **Hydrogen** (Read as Sulphuric acid with Sulphate, As Water with Hydroxide) | $Ca^{+2}$ **Calcium** |

**I heard....**

**I forgot**

**I saw....**

**I remembered**

**I did....**

**I understood**

I do not know what I may appear to the world, but to myself I seem to have been only a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.
- Isaac Newton

**SAHAJ-Shishu Milap, Vadodara**